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Factors Limiting the Fortymile Caribou Herd

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RESEARCH PROGRESS REPORT

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SUMMARY

For 2 consecutive years we have made major progress in defining factors limiting the Fortymile Herd. Deployment of radiocollars on newborn and older caribou (*Rangifer tarandus granti*) and regular monitoring allowed investigations of caribou productivity and causes and rate of mortality. These data allowed us to complete a model illustrating how predation versus other demographic factors affected herd size from mid May 1994 through early May 1996.

To summarize, of the 20,000 adults and yearlings and 8260 calves present in mid May 1994, we estimate wolves (*Canis lupus*) killed 3940 (14%) within 12 months. In contrast, grizzly bears (*Ursus arctos*) killed 2020 (7%), other predators killed 860 (3%), hunters killed 335 (1%), and nonpredation accounted for 1080 deaths (4%). This model indicates the population trend was essentially stable during 1994-1995, which is consistent with independent photocensus totals from 1990, 1992, 1994, and 1995.

The primary difference in the 1995-1996 model was that herd size increased. The model indicates this increase occurred because wolves killed several hundred fewer adult caribou and nonpredation deaths among calves declined. An increase in herd size was also documented using an independent photocensus in June 1996. We counted 23,458 caribou in June 1996 compared with 22,558 in June 1995.

The Fortymile Planning Team completed a new Fortymile Caribou Herd Management Plan (Appendix A:57-78) during 1995. The primary goal of this new plan is to restore the Fortymile Herd to its former range, which entails initiating management actions to increase herd size. In response, we drafted a new 5-year research plan (1997-2001, Appendix A), which presents, in detail, management actions proposed by the Fortymile Team. Results of current research will provide pretreatment data, which will allow us to evaluate the effectiveness of actions used to elevate caribou numbers.

The following points will assist with continuing efforts to evaluate the new management objectives:

1 Herd numbers remained relatively stable during 1990-1995 (about 22,000 to 23,000 caribou) compared with annual growth rates of 7% to 10% in the 1980s. During 1996 the herd increased about 4%, in part, because of reduced wolf predation. This reduced wolf predation probably resulted from a combination of factors including elevated wolf harvest rates on the wintering grounds and more favorable weather (e.g., less snow). With less snow, wolves are less successful at killing caribou and caribou are in better condition.

2 Wolves and grizzly bears continue to be the major factors limiting herd growth, despite over a decade of the most liberal regulations in the state for private harvesting of wolves and grizzly bears.

3 Reducing harvest of caribou to minimal levels is insufficient to achieve time-specific objectives for elevated caribou numbers. For example, humans harvested $\leq 1.5\%$ (bulls-only) of the midsummer population in 1995 and 1996, which had negligible effects on the herd's population dynamics. Also, bull caribou are plentiful in the Fortymile Herd. Bull:cow ratios in the Fortymile Herd (42-49 bulls:100 cows during 1992-1995) are not reduced by harvest compared with ratios from the only Interior Alaska herd with no harvest in recent decades (39-44 bulls:100 cows in the Denali Herd, 1992-1994). Bull:cow ratios remain high (43 bulls:100 cows in Oct 1995) because harvests have intentionally been held low since 1973 to encourage herd growth. Further reduction of harvest rates will not result in significant herd growth (Appendix B and C).

4 Adverse weather presumably contributed to increased predation rates during 1990-1995, compared with the 1980s, and probably contributed to reduced natality in 1993.

5 Winter range can support elevated caribou numbers both in regard to lichen availability on currently used winter range and the availability of vast expanses of winter range formerly used by the herd.

The most significant factor now limiting Fortymile Herd growth is predation on calves. Natural adult mortality and harvest are at minimal levels, and natality rates increased to average reported levels (82% to 85%) in 1994 and 1995 and an unusually high level (97%) in 1996. We will continue studies of Fortymile calf mortality during 1996 and, possibly, 1997 by deploying radiocollars on newborns. These studies will allow evaluation of the annual variability in the causes and extent of calf mortality before management actions are implemented to increase herd size.

Key words: Alaska, caribou, condition, Fortymile Caribou Herd, management objectives, mortality, nutritional status, pregnancy rate.

CONTENTS

BACKGROUND

The Fortymile Caribou (*Rangifer tarandus granti*) Herd has the potential to be the most economically important wildlife population in Interior Alaska and the southern Yukon for consumptive and nonconsumptive uses. Potential for growth is indicated by Murie's (1935) estimate of 568,000 caribou during a 20-day migration across the Steese Highway in 1920, compared with an aerial photocensus of 23,458 caribou in June 1996.

Caribou herds typically restrict range use as herd size declines. For example, the Fortymile Herd has not migrated across the Steese Highway for several decades and rarely enters the Yukon because of its reduced size. The herd's historical range encompassed 220,000 km^2 (Murie 1935) compared with about 50,000 km^2 total for all years since 1968 (Valkenburg et al. 1994; Fig 1). Today, the historical range of the herd is largely devoid of caribou.

Population objectives for increasing the Fortymile Caribou Herd have wide public support in Alaska and the Yukon for consumptive and nonconsumptive reasons. This public support has developed because most of the herd's former range was abandoned as herd size declined and because current low numbers are, in part, a result of past errors in the predominant management beliefs.

We have learned much from management of the Fortymile Herd. Valkenburg et al. (1994) detailed a case history of the herd from 1920 to 1990. The decline in the herd from about 50,000 in 1960 to only 6500 in 1973 was partly a result of errors in the predominant management beliefs. Overharvest was allowed in the early 1970s, and, simultaneously, high numbers of wolves (*Canis lupus*) and unfavorable weather contributed to the herd's decline to critically low levels (Davis et al. 1978, Valkenburg and Davis 1989, Valkenburg et al. 1994). Had this overharvest been prevented, the herd would probably have declined to only 10,000-20,000 caribou during the early 1970s and may have increased to 30,000-50,000 during favorable conditions in the 1980s.

Overharvest was allowed in the early 1970s in part because of the belief that poor range condition was the major factor causing low yearling recruitment. Thus, biologists allowed high harvests and largely ignored wolf predation while awaiting a compensatory rebound in yearling recruitment from improved range. However, it was a futile vigil; calf caribou became increasingly scarce through 1973. It was mistakenly believed hunters and predators mostly killed animals that would die before successfully reproducing and wolf and grizzly bear (*Ursus arctos*) predation were minor influences on the herd. Also, the size of the Fortymile Herd was grossly overestimated and the trend in herd size inadequately monitored (Davis et al. 1978, Valkenburg and Davis 1989).

Today harvest programs for caribou are managed much more conservatively than in the 1970s, especially during natural declines of caribou to low levels. Since 1984 radiocollaring of Fortymile caribou has provided the ability to efficiently estimate herd size, recruitment, mortality, causes of mortality, and relative nutritional status (Valkenburg and Davis 1989, Valkenburg et al. 1994). Today managers know adverse weather can initiate declines in caribou herds (Valkenburg et al. 1994, Adams et al. 1995*a*, Boertje et al. 1996). Adverse

weather in Interior Alaska in the early 1990s and the simultaneous decline of several Interior caribou herds were, in part, the stimuli for this renewed study of the Fortymile Herd.

During periods of adverse weather, herd condition can decline and predation can increase (Mech et al. 1995, Boertje et al. 1996). After weather improves, prolonged declines in caribou herds can occur from continued high wolf predation because wolves switch to caribou as primary prey and because declines in wolf numbers lag behind declines in caribou (predator lag). Examples exist where the proportion of a herd killed by wolves increased during adverse weather because caribou were more vulnerable and wolf numbers increased as caribou declined (Adams et al. 1995*a*; Mech et al. 1995, Boertje et al. 1996). Today it is a well-accepted belief that wolf and bear predation are often the major factors limiting caribou and moose (*Alces alces*) at low densities (Davis et al. 1978, 1983; Gasaway et al. 1983, 1992; Boertje et al. 1987, 1988; Larsen et al. 1989; Valkenburg and Davis 1989; Adams et al. 1995*b*; Boertje et al. 1996).

Ungulate-predator relationships were studied in a portion of the Fortymile Herd's range during the mid-1970s and 1980s (Davis et al. 1978; Boertje et al. 1987, 1988; Valkenburg and Davis 1989; Gasaway et al. 1992). These studies summarized historical and recent predator-prey relationships and documented predation as the major factor limiting recovery of caribou and moose populations in the area.

From 1981 through 1987, management actions were implemented to reduce grizzly bear and wolf predation in a portion of the Fortymile Herd's range (Valkenburg and Davis 1989, Gasaway et al. 1992). Control of wolf numbers by department personnel was terminated before desired reductions were achieved, and grizzly bear numbers were only moderately reduced in a small portion of the range. Subsequent 7% to 10% annual increases in caribou numbers could not be definitively linked to predator control because pretreatment studies were lacking and only small reductions in predator abundance occurred in the annual range of the Fortymile Herd (Valkenburg et al. 1994).

To definitively test the effectiveness of predator control, large reductions in predator abundance are necessary for several years (Crete and Jolicoeur 1987; Larsen and Ward 1995; Boertje et al. 1996; Farnell and Hayes, unpubl data). Large reductions in wolf numbers for several years resulted in dramatic increases in caribou numbers in central Alaska (16% per year; Gasaway et al. 1983, Boertje et al. 1996) and eastcentral Yukon (18% per year; Farnell and MacDonald 1988; Larsen and Ward 1995; Farnell and Hayes, unpubl data). In both studies, only 15% to 31% of the original precontrol wolf numbers remained by late winter during the 4 to 6 winters of effective control efforts. These are the only well-documented studies where large reductions of wolves were temporarily maintained for more than 2 winters.

MANAGEMENT OBJECTIVES

International draft management objectives from the mid-1980s through 1995 called for increasing the herd to 50,000 adults or 60,000 caribou by the year 2000. These management objectives were written when the herd was growing at 7% to 10% per year and when

population objectives would have been attained naturally. Instead, herd numbers were nearly stable between 1990 and 1995.

Increased harvests of wolves and grizzly bears in the 1980s were insufficient to allow for herd growth during 1990-1995, presumably because predators were not sufficiently reduced and adverse weather occurred. Substantial reductions in the human harvest of caribou were begun in 1973 to allow for herd growth. Since 1973, human harvest of caribou has been an insignificant factor affecting herd growth compared with predation by wolves and bears (Valkenburg et al. 1994, Appendix B and C).

During autumn 1994 the Fortymile Planning Team was formed (Appendix A:70) to write a new Fortymile Caribou Herd Management Plan (Appendix A:57-78). The primary goal of this plan is to restore the Fortymile Herd to its former range, which entails initiating management actions to increase herd size. In response, we drafted a new 5-year research plan (1997-2002, Appendix A:28-56) which presents, in detail, management actions proposed by the Fortymile Team. Results of the current research project will provide baseline pretreatment data, allowing us to evaluate the effectiveness of actions used to elevate herd numbers.

Objectives of the new plan include increasing herd numbers by at least 5% to 10% per year through the year 2002. Management actions are to include fertility control in dominant wolf pairs in up to 15 packs, translocation of the remaining wolves in these 15 packs, diversionary feeding of wolves at dens, reduced caribou harvest quotas, encouraging trappers to shift trapping to this area, and possibly translocation of grizzly bears from calving areas during the final spring. Herd response to these management actions will depend largely on changes in wolf and bear predation, weather, and caribou distribution and productivity. Thus, response to the proposed management actions could vary considerably between years.

GOAL

Our goal is to determine demographics of the Fortymile Caribou Herd, herd condition (nutritional status), and factors limiting the herd for the purpose of 1) predicting how herd growth rate may respond to potential predator management and harvest management programs and 2) evaluating responses to potential programs implemented through the ongoing planning process. We will use historical and current data to help predict herd responses to management actions.

JOB OBJECTIVES

1 Literature review.

2 Assess extent and cause of death among collared caribou ≥ 4 months old.

3 Estimate herd condition.

4 Estimate age-specific mortality rates by collaring 4-month-old calves.

5 Determine total numbers and population trend.

6 Estimate recruitment and mortality rates during the first 4 months of life by annually classifying caribou about 1 October 1993-1997.

7 Evaluate winter range condition with respect to relative lichen versus moss abundance in caribou feces.

8 Determine extent and cause of death among calves during the first year of life.

9 Determine what weather factors are related to poor herd condition.

10 Analyze data and draft figures for written and oral presentations of data.

11 Write progress reports and either publish a final report or recommend continuation of this study for 5 additional years.

12 Incorporate results into appropriate Alaska wildlife management plans and survey-inventory activities.

METHODS

Estimating Herd Numbers and Growth Rate From Censuses

We estimated minimum numbers of Fortymile caribou during June or early July 1990, 1992, 1994, 1995, and 1996 using a radiosearch, total search, aerial photo technique (Valkenburg et al. 1985), as in previous estimates of herd size during the 1970s and 1980s (Valkenburg and Davis 1989). To date, we have used photocensus data to calculate growth rates of the herd. We also used data on herd composition, natality, and mortality to estimate population trends, because, occasionally, in photocensuses we have substantially underestimated caribou numbers in the Delta Herd (Boertje et al. 1996). Experience has shown we cannot necessarily detect annual trends in caribou numbers by comparing 2 consecutive photocensuses of the Delta Herd; the degree of underestimation varies and is strongest when adverse weather interrupts the census and when caribou are poorly aggregated (Boertje et al. 1996).

Estimating Trend From Data on Herd Composition, Natality, and Mortality

We combined data on herd composition, natality, and mortality to model the herd's trend independent of photocensus data. To estimate herd composition, caribou were classified from a helicopter during late September or early October 1991-1995 using the distribution of radiocollared caribou to randomly select caribou for counting. Classifications were corrected for the random distribution of radiocollars when necessary. Cows, calves, and small, medium, and large bulls were counted.

We estimated natality rates of the herd by documenting the presence or absence of a calf, hard antlers, and/or a distended udder among radiocollared female caribou ≥ 24 months old (Whitten 1995). Pregnancy was easy to confirm using these techniques. To confirm nonpregnancy, we repeated observations at least twice during 11- 31 May in 1984-1996.

We estimated age-specific mortality rates from October 1992 to October 1995 by radiolocating all collared caribou 1 or 2 times monthly. In addition, in 1992 and 1993 we flew daily between 13 May and 3 June and, during 1994 through 1996, we flew daily between 11 May and 31 May, 10-13 times in June, and weekly during July through September. Radiocollars contained a mortality sensor that doubled the pulse rate if the collar remained motionless for 1.5 hours (newborn calf collars) or 6 hours (other collars). Annual mortality rate (M) was calculated as M = A / B x 100, where A = the number of caribou dying during the 12-month period, and B = the total number of animals collared at the beginning of the 12-month period.

We radiocollared (Telonics, Mesa, Ariz) 41 caribou from 27 September to 22 October 1991, 3 on 7 March 1992, 14 from 28 September to 30 September 1992, 14 on 4 October 1993, 14 on 1 October 1994, and 15 on 29 September 1995. We also assisted the Bureau of Land Management collar 17 caribou from 3 April to 29 April 1992. Caribou were darted from a helicopter using 2 cc Cap-Chur darts with 1.9 cm barbed needles. Except during autumns 1992 through 1995, darts contained 1.5 mg carfentanil citrate (Wildnil®, Wildlife Pharmaceuticals, Fort Collins, Colo), 67 g xylazine hydrochloride (Anased®, Lloyd Laboratories, Shenandoah, Ia) and 0.85 cc of propylene glycol. During autumns 1992 through 1995, we darted only calves and used 1 mg carfentanil citrate and 67 mg xylazine hydrochloride. Most calves were heavily sedated by this dose. For recovery of calves, we administered 100 mg naltrexone hydrochloride (Trexonil®, Wildlife Pharmaceuticals) and 10 mg yohimbine hydrochloride (Antagonil®, Wildlife Pharmaceuticals) intramuscularly. We radiocollared 50 newborn calves in May 1994, 52 in 1995, and 60 in May 1996, using techniques described by Adams et al. (1995*b*), except we used a 2-person, Robinson R-22 helicopter.

Evaluating Causes of Natural Mortality

To evaluate causes of death among caribou during their first 4 months of life, we used criteria and techniques described by Adams et al. (1995*b*). To assess cause of death for caribou older than 4 months, we examined death sites within a few days to a few weeks of each mortality using a helicopter, Bellanca Scout, or Supercub for access. Blood (noncoagulated) on collars or on remnants of hide served as evidence of a violent death. In these cases scats, tracks, other signs, and season of kill (bears hibernating in winter) served to identify the predator. A radiocollar soaked in blood was indicative of lynx predation, based on evidence of lynx predation in the snow at several sites.

Estimating Caribou Harvest

Procedures for estimating total and female caribou harvest varied, depending on the type of harvest reporting system. In all years, we included estimates of illegal harvest made during road and trail surveys. We considered harvest reports collected from permit hunts to be accurate estimates of total harvest because reminder letters were sent to permittees and about 97% of permittees responded. All harvest since 1993 and most harvest during 1990-1992 was conducted under permit hunts.

During general season hunts (1980s and early 1990s), harvest was reported by mandatory mail-in report cards without the benefit of reminder letters. We applied a correction factor to all general season hunts (reported harvest x 1.59). This correction factor was derived from road

and transporter surveys in 1983. To avoid biased reporting, hunters were not told the purpose of the road surveys. The surveys and subsequent mail-in harvest reports were treated as a mark-recapture sample to estimate total harvest.

Estimating Wolf Harvest

We estimated wolf harvest rates within annual ranges of the Fortymile Caribou Herd for the years 1992-1993 through 1995-1996. Annual ranges of the herd were delineated based on telemetry flights beginning 1 October. Wolf densities were then extrapolated to this area based on annual estimates of wolf densities from radiocollared wolf packs and wolf surveys in most of the area. Mandatory reporting forms provided information on wolf harvest locations. Regulations allowed wolf hunting during 10 August-30 April and wolf trapping during 15 October-30 April.

Evaluating Herd Condition/Nutritional Status

Five indices were used to evaluate relative condition/nutritional status of the herd: 1) live weights of autumn and newborn calves, 2) percent mortality of calves of radiocollared cows during the first 2 days of life (i.e., perinatal mortality), 3) percent natality of radiocollared cows, 4) age of first reproduction, and 5) median calving date. We weighed 14 or 15 female calves in late September or early October 1991 through 1995. Methods for determining birthweights of calves followed Adams et al. (1995*b*), e.g., 0.6 kg was subtracted for each day of age > 1; 21% of the calves were > 1 day old.

High calf mortality (e.g., 20% to 30%) during the first 2 days of life has been linked to malnutrition; we evaluated this factor as an index to herd nutritional status (Whitten et al. 1992, Adams et al. 1995*a*). To detect calf mortality during the first 2 days of life, we observed a radiocollared sample of adult cows on consecutive days during calving seasons 1992 through 1996. Cows were observed each day until they gave birth and on the first 2 consecutive days after birth. During 1994-1996, we determined the cause of death among several of these calves to test the hypothesis that early mortality was attributable to malnutrition.

Daily radiolocations during the 1992 through 1996 calving seasons occurred as follows. In 1992 we radiolocated 30 adult females on 14 May and from 19 May through 3 June 1992. In 1993 we radiolocated 48 adult females on 13 May, 16-28 May, and 3 June. In 1994 we radiolocated 45 adult females from 14 May through 31 May. In 1995 we radiolocated 41 adult females from 11 May through 30 May. In 1996 we radiolocated 39 adult females from 12 May through 30 May. The median calving date was the date by which 50% of the adult radiocollared females had given birth. Delayed calving indicates malnutrition (Espmark 1980, Reimers et al. 1983, Skogland 1985).

Identifying Adverse Weather

Nutritional indices will be compared with weather indices to determine what weather indices, if any, can be linked to poor caribou nutrition. For example, are hot, dry summers or deep snows, or both, correlated with herd condition or nutritional status? Also, is performance of the herd strongly linked to malnutrition during adverse weather? Or can recruitment vary independently

of nutrition because of overwhelming effects of predation? We plan to use Alaska weather data from Eagle, when available, to describe summer temperature and precipitation. We will attempt to analyze snow data from 6 weather stations surrounding the Fortymile range (Fig 1). Snow data will be corrected for elevation and distribution using universal block kriging (Cressie 1991:179).

Evaluating Lichen Versus Moss Component of the Herd's Winter Diet to Assess Range Condition

We collected 13 fecal samples from the Fortymile Herd winter range during March and early April 1992 and 1993. Each sample contained 25 pellets; 1 pellet was collected from each of 25 different piles found afield (Boertje et al. 1985). Samples were analyzed at the Composition Analysis Laboratory in Fort Collins, Colorado. We collected an additional 12 samples during winters 1993-1994 through 1995-1996; data are forthcoming.

RESULTS AND DISCUSSION

Herd Numbers and Trend

The first systematic estimate of herd numbers occurred in 1920 when several observers counted portions of the Fortymile Caribou Herd crossing the Steese Highway on a 20-day autumn migration that was 60 miles wide. Murie's (1935:6) extrapolated estimate in 1920 was a "conservative" 568,000. The low point for the herd came during 1973-1975 when the first photocensuses were conducted and only 5740 to 8610 caribou remained (Valkenburg et al. 1994).

Herd numbers increased during the late 1970s and 1980s at annual rates of 7% to 10% (Valkenburg et al. 1994). Estimates of calf recruitment in early October and our estimates of adult mortality based on radiocollared cows indicate the herd peaked in 1989 with about 23,000 caribou. Herd numbers probably declined slightly through June 1992 and were stable from June 1992 through June 1995. Photocensuses corroborate the stable trend during 1990-1995, with approximately 22,000 to 23,000 caribou in the herd. Most recently we counted 23,458 caribou on 21 June 1996, which indicates an increasing trend (Table 1). An increase was also predicted using 1995-1996 natality, composition, and mortality data (Table 1; Appendix C).

Timing, Rates, and Causes of Age-Specific Natural Mortality

During the combined calving seasons of 1994-1996, we observed newborn calves during 11-28 May. By the end of June each year, 40% to 50% of the calves were dead. Another 20% died before reaching the age of 1 year (Figs 2 and 3). This pattern of births and deaths is similar to that found in other Interior Alaskan caribou studies (Adams et al. 1995*b*; Valkenburg, unpubl data).

We examined the rates (1992-1996) and causes (1994-1996) of mortality among calves during their first 2 days of life to test whether perinatal mortality in the Fortymile Herd is caused largely by nutrition-related factors, as concluded by studies of the Porcupine and Denali herds

(Whitten et al. 1992, Adams et al. 1995*a*). We found no convincing support for this hypothesis in the Fortymile Herd. Instead, predation was documented as the major cause of death among calves ≤ 2 days old in 16 (73%) of 22 cases. Also, rates of perinatal mortality were highly variable among years and not higher in 1993 when nutritional status was low (see Herd Nutritional Status and Adverse Weather). Perinatal mortality rates observed among offspring of collared cows were 3% ($n = 30$) in 1992, 14% ($n = 28$) in 1993, 22% ($n = 32$) in 1994, 7% ($n = 28$) in 1995, and 21% ($n = 38$) in 1996. In conclusion, we do not recommend mortality rates among young Fortymile calves be used as an index to herd nutritional status.

We summarize data here on causes and rates of calf mortality (1994 and 1995 cohorts) to characterize these parameters prior to management actions planned for the 1997-2001 cohorts (Appendix A). For the 1994 calf cohort, the annual mortality rate totaled 71% ($n = 55$) and wolves and grizzly bears, together, killed 24 (71%) of the 34 calves that died from known causes (Fig 4). We attributed 13 (38%) of these 34 deaths to wolves, 11 (32%) to grizzly bears, 3 (9%) to eagles, 3 (9%) to accidents (broken legs), 1 (3%) to a black bear, 1 (3%) to a wolverine, 1 (3%) to abandonment, and 1 (3%) to suffocation at birth. Two summer mortalities caused by either wolves or grizzly bears were divided between the 2 predators.

For the 1995 cohort, the annual mortality rate totaled 59% ($n = 54$) and wolves and grizzly bears killed 21 (70%) of the 30 calves that died from known causes (Fig 5). We attributed 13 (43%) of these 30 deaths to wolves, 8 (27%) to grizzly bears, 4 (13%) to black bears, 3 (10%) to eagles, 1 (3%) to a wolverine, and 1 (3%) to an accident.

Wolf predation has consistently been the major cause of death among caribou older than 4 months. Of the 46 caribou older than 4 months for which cause of death was determined (Oct 1991-July 1996), wolves killed 39 (85%), lynx killed 2 (4%), grizzly bears killed 2 (4%), and 3 (7%) died from nonpredation deaths. A large majority (87%) of these deaths occurred during October through April (7 months). Lynx killed only calves. Of the 23 calves killed between the ages of 4 and 12 months, wolves killed 20, lynx killed 2, and 1 died from nonpredation causes.

Elevated mortality from age 4 to 16 months in the 1991 cohort (57%, $n = 14$, Table 1) may have been associated with inadvertent separation of calves from their dams at collaring (27 Sep-22 Oct). We darted calves and their dams simultaneously in 1991 and only 2 of 14 cow-calf pairs reunited after recovery from drugging. In 1990 and 1992 through 1994, we radiocollared calves, but not their dams, and cow-calf pairs consistently reunited. Implications of these data are that human hunting of cows with calves during autumn or early winter may reduce the survival of orphaned calves where wolves are major predators. Seven (88%) of the 8 dead calves were killed by wolves.

POPULATION MODELING

We completed 2 annual models using data on natality, mortality, herd size, and composition to illustrate the relative importance of predation versus other demographic factors affecting the Fortymile Caribou Herd (Figs 6 and 7 based on Appendices B and C). From 11 May 1994 through 10 May 1995, we estimated herd trend was stable because annual deaths

approximately equaled births. Annual deaths totaled 8200 of which wolves accounted for 48%, grizzly bears 24%, other predators 10%, nonpredation 13%, and hunters 4% (Fig 6). Wolves killed an estimated 14% of the 1994 postcalving population in 1 year (2240 calves and 1680 adults and yearlings). In contrast, grizzly bears killed 7% of the postcalving population in 1 year (1900 calves and 100 adults and yearlings), other predators killed 3%, hunters killed 1%, and nonpredation took 4%.

The primary difference in the 1995-1996 model was that herd size increased because wolves killed several hundred fewer adult caribou and nonpredation deaths among calves declined (Fig 7). An increase in herd size was also documented using an independent photocensus in June 1996. From 11 May 1995 through 10 May 1996, we estimated annual deaths totaled 6500 of which wolves accounted for 50%, grizzly bears 22%, other predators 20%, nonpredation 4%, and hunters 3%. Wolves killed an estimated 11% of the 1995 postcalving population in 1 year (2170 calves and 1050 adults and yearlings). In contrast, grizzly bears killed 5% of the postcalving population in 1 year (1330 calves and 60 adults and yearlings), other predators killed 5%, hunters killed 1%, and nonpredation took 1%.

Caribou Harvest

Reducing harvest of caribou to minimal levels is insufficient to achieve time-specific objectives for elevated caribou numbers because other factors more strongly affect herd dynamics (Appendix B and C). For example, humans harvested 1% (bulls only) of the postcalving population in 1995 and 1996, while wolves killed 11% to 14% (Figs 6 and 7). Estimated total annual harvest averaged 2.8% of the midsummer herd size during the 6 years before 1990. At this time, harvest was intentionally reduced because natural mortality increased and recruitment declined (Table 1). Since 1990 harvest has averaged about 1.8% of the midsummer herd size. Virtually all legal harvest has consisted of bull caribou, and 93% of estimated legal and illegal harvest since 1984 consisted of bulls.

Restricted harvests of bull caribou do not necessarily provide for herd growth because each bull can impregnate many cows. In reindeer herds, a bull will impregnate 15 to 25 cows, so 4 to 6 bulls per 100 cows are considered sufficient for breeding (Sjenneberg and Slagsvold 1968). Bull caribou are plentiful in the Fortymile Caribou Herd. Bull:cow ratios in the Fortymile Herd (42-49 bulls:100 cows, 1992-1995) are not reduced by harvest compared with ratios from the only Interior Alaska herd with no harvest in recent decades (39-44 bulls:100 cows in the Denali Herd, 1992-1994). Bull:cow ratios remain high (43 bulls:100 cows in Oct 1995) because harvests have intentionally been held low since 1973 to encourage herd growth. Further reducing harvest rates of bulls will not result in significant herd growth.

Wolf Harvest

The Fortymile Caribou Calf Protection Program, a group of private citizens, paid $400 per wolf from a large area including most of the Fortymile Herd's range beginning during winter 1995-1996. This $400 approximately doubled the market value of pelts and was provided to stimulate increased wolf harvest with the goal of increasing the Fortymile Herd.

To evaluate the effect of the Caribou Calf Protection Program on the herd's wolf population, we compiled estimates of the wolf harvest rates from within the herd's annual range for 3 years before the program and during the first year of the program. Preliminary data indicate wolf harvest rates were approximately 20% to 30% during the 3 winters before the program and approximately 60% during the first year of the program. Refined estimates and implications of these data are forthcoming in the final report.

HERD NUTRITIONAL STATUS AND ADVERSE WEATHER

We found no convincing support for using perinatal mortality rates to evaluate nutritional status (see Timing, Rates, and Causes of Age-Specific Natural Mortality). Of the remaining potential indices of herd condition/nutritional status, natality rate and age of first reproduction were most negatively affected by the adverse weather of 1992. Only 126 snow-free days occurred in Fairbanks in 1992 compared with 160 to 199 days during the previous 19 years (Boertje et al. 1996). Snow melt was several weeks late during spring 1992, and snowfall was several weeks early in autumn 1992. Many adult cows apparently did not gain sufficient fat to breed in 1992. The natality rate in 1993 was low in the Fortymile Herd (68%; Table 1) and the Delta Herd (30%; Valkenburg 1994). Natality rates for caribou are commonly ≥ 82% (Table 1; Bergerud 1980). Only 5 (42%) of 12 3-year-olds produced calves in the Fortymile Herd in 1993, compared with 5 (83%) of 6 in 1994, 5 (71%) of 7 in 1995, and 9 (100%) of 9 in 1996.

October calf weights were not significantly lower in 1992 (Table 2). Median calving date was not late in 1993 (22 May, $n = 25$) compared with 1992 (23 May, $n = 25$). However, calving in both years was late relative to calving after the mild winter of 1993-1994 (18 May, $n = 31$).

Recommendations for acquiring meaningful indices to Fortymile Herd nutritional status are forthcoming in the final report. Data from natality rates probably provide indices to the previous summer/autumn condition, whereas birthweights and calving dates probably provide indices to winter and spring conditions. Data on natality rates indicate caribou nutritional status was poor in autumn 1992, excellent in autumn 1995, and average in autumn 1991, 1993, and 1994 (Table 1). Birthweights are available from only 3 years (1994-1996). During 1994 male calves weighed 7.60 kg ($n = 22$, SE = 0.185) and females weighed 7.47 kg ($n = 22$, SE = 0.257). During 1995 males weighed 8.45 kg ($n = 24$, SE = 0.136) and females weighed 7.68 kg ($n = 25$, SE = 0.161). During 1996 males weighed 8.47 kg ($n = 26$, SE = 0.228) and females weighed 8.05 kg ($n = 32$, SE = 0.160). Median calving dates were: 23 May in 1992 ($n = 25$), 22 May in 1993 ($n = 24$), 18 May in 1994 ($n = 32$), 20 May in 1995 ($n = 28$), and 18 May in 1996 ($n = 37$).

From 1952 to 1990, proportions of calves in September or October were positively correlated with July rainfall and negatively correlated with an index to snow depth (Valkenburg et al. 1994). The snow index was correlated with July temperature and negatively correlated with July rainfall, indicating high snowfall winters were usually followed by relatively warm and dry conditions in July and poor calf survival. We have not yet analyzed weather data from the 1990s.

We hope to further explore whether annual fluctuations in caribou numbers can be explained, in part, by extremes in weather patterns and resulting nutritional status. Because we saw no strong decline in caribou numbers during 1992 when nutritional status was poor, we conclude that periodic poor nutritional status has not been as strong a factor affecting caribou numbers in the Fortymile Herd as in the Delta and Denali herds.

RANGE CONDITION

Range condition seemed excellent during winters 1991-1992 and 1992-1993, as evidenced by high proportions (x = 72% to 81%) of lichen fragments in caribou fecal samples (Table 3). Samples were collected from different wintering areas each year (Fig 8). Samples collected during winters 1993-1996 are undergoing analysis. Boertje (1981) and Boertje et al. (1985) provided data showing the usefulness of fecal samples in evaluating use of lichens on winter ranges. Lichens are slower growing than vascular plants and are a highly preferred winter forage. Fecal samples from overgrazed winter ranges contained higher proportions of mosses and evergreen shrubs and reduced proportions of lichens compared with values observed in this study.

OTHER ACTIVITIES

Preliminary data were presented at an interagency and international meeting focusing on Fortymile Herd management in Tok on 9 February 1994. This meeting stimulated the creation of the Fortymile Planning Team responsible for writing the new Fortymile Herd Management Plan (Appendix A:57-78). Several presentations of research data were made to the Fortymile Team and the Board of Game during the planning process. Research data were also incorporated into 3 editions of *The Comeback Trail* and various management reports. *The Comeback Trail* is a newsletter aimed at keeping the public and agencies informed of Fortymile Herd planning, management, and research. This newsletter is published by ADF&G.

CONCLUSIONS

For those considering future management direction of the Fortymile Herd, several points are significant:

1 Herd numbers remained relatively stable in the 1990s, compared with annual growth rates of 7% to 10% in the 1980s.

2 Wolves and grizzly bears continue to be the major factors limiting Fortymile Herd growth, despite over a decade of the most liberal regulations in the state for public harvesting of wolves and grizzly bears.

3 Harvest of Fortymile caribou has been intentionally restricted to allow for growth of the herd, but minimizing harvest is insufficient to achieve time-specific objectives for elevated caribou numbers. For example, harvest was only about 225 bull caribou during the 1995-1996 hunting season (< 1% of the postcalving population), and bull caribou are plentiful in the herd compared to unhunted herds.

4 Adverse weather has contributed to reduced natality and, presumably, increased predation rates in some recent years, compared with the 1980s.

5 Winter range can support elevated caribou numbers both in regard to lichen availability on currently used winter range and availability of vast expanses of former winter range.

Assuring achievement of time-specific objectives for increased caribou numbers will depend on actions that measurably reduce predation. Reducing predation is a value-based socioeconomic and political decision beyond the scope of this report. Ecological and biological issues are more easily addressed. For example, sustainable harvest of a caribou herd is ecologically sound compared with dependency on alternative livestock and agricultural industries. Past studies have shown wolf reductions can be biologically effective and sound, i.e., 1) caribou herds can grow rapidly following large reductions in wolf numbers and 2) wolf numbers can recover within a few years (Larsen and Ward 1995, Boertje et al. 1996).

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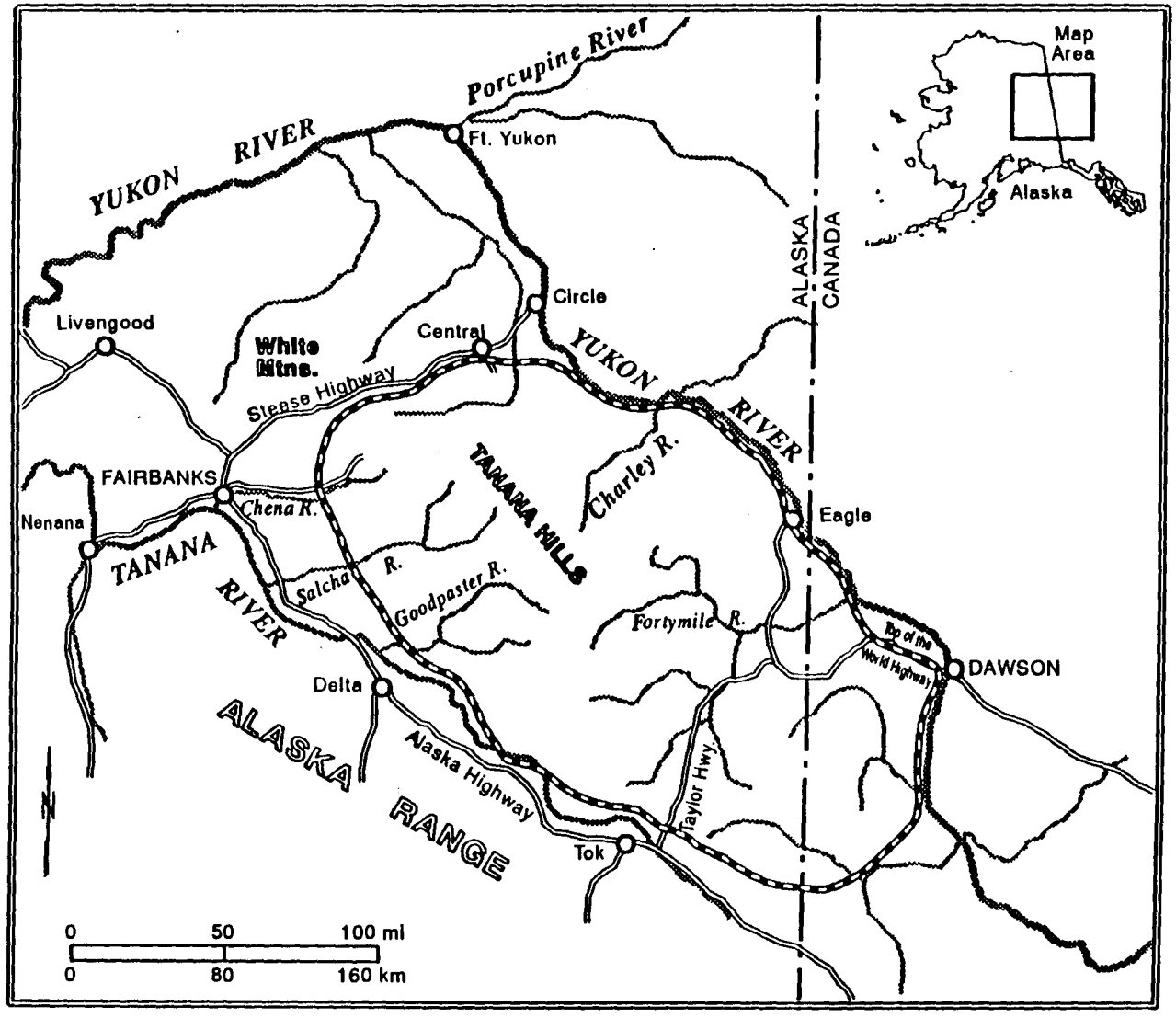

Figure 1 Range of the Fortymile Caribou Herd, 1984-1996

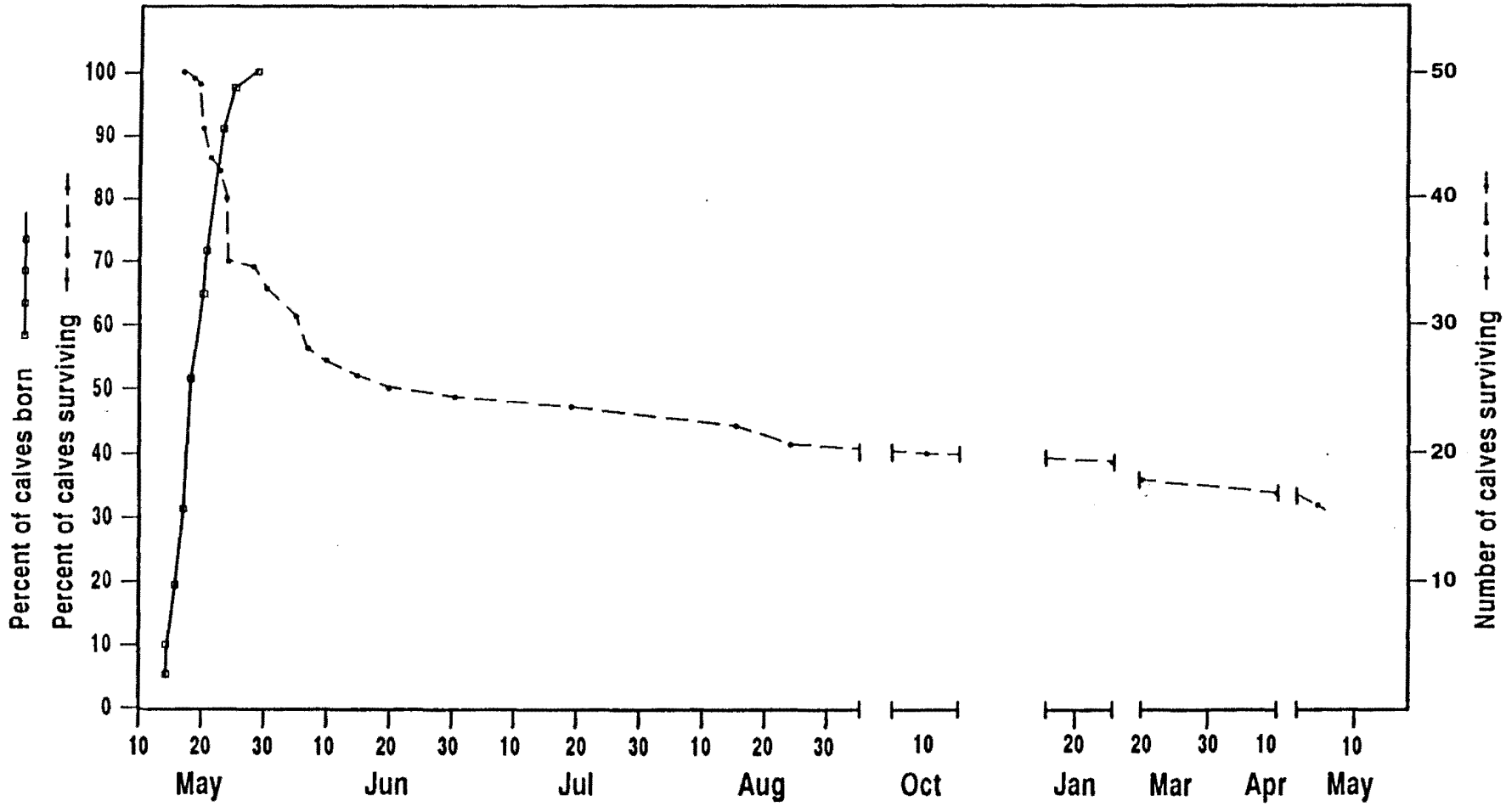

Figure 2 Chronology of births and deaths among 50 caribou calves from May 1994 through May 1995, Fortymile Caribou Herd, eastcentral Alaska

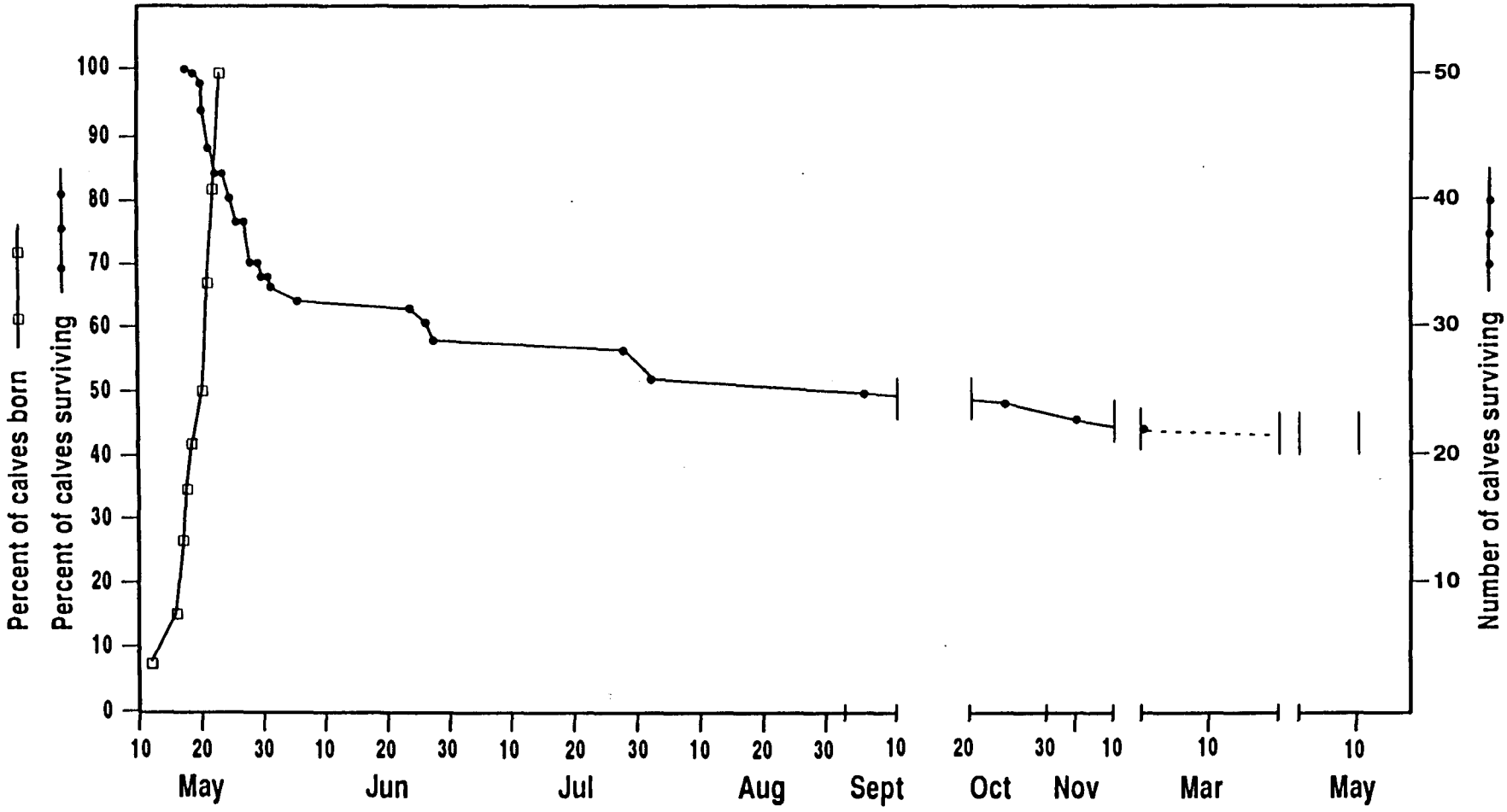

Figure 3 Chronology of births and deaths among 52 caribou calves from May 1995 through May 1996, Fortymile Caribou Herd, eastcentral Alaska

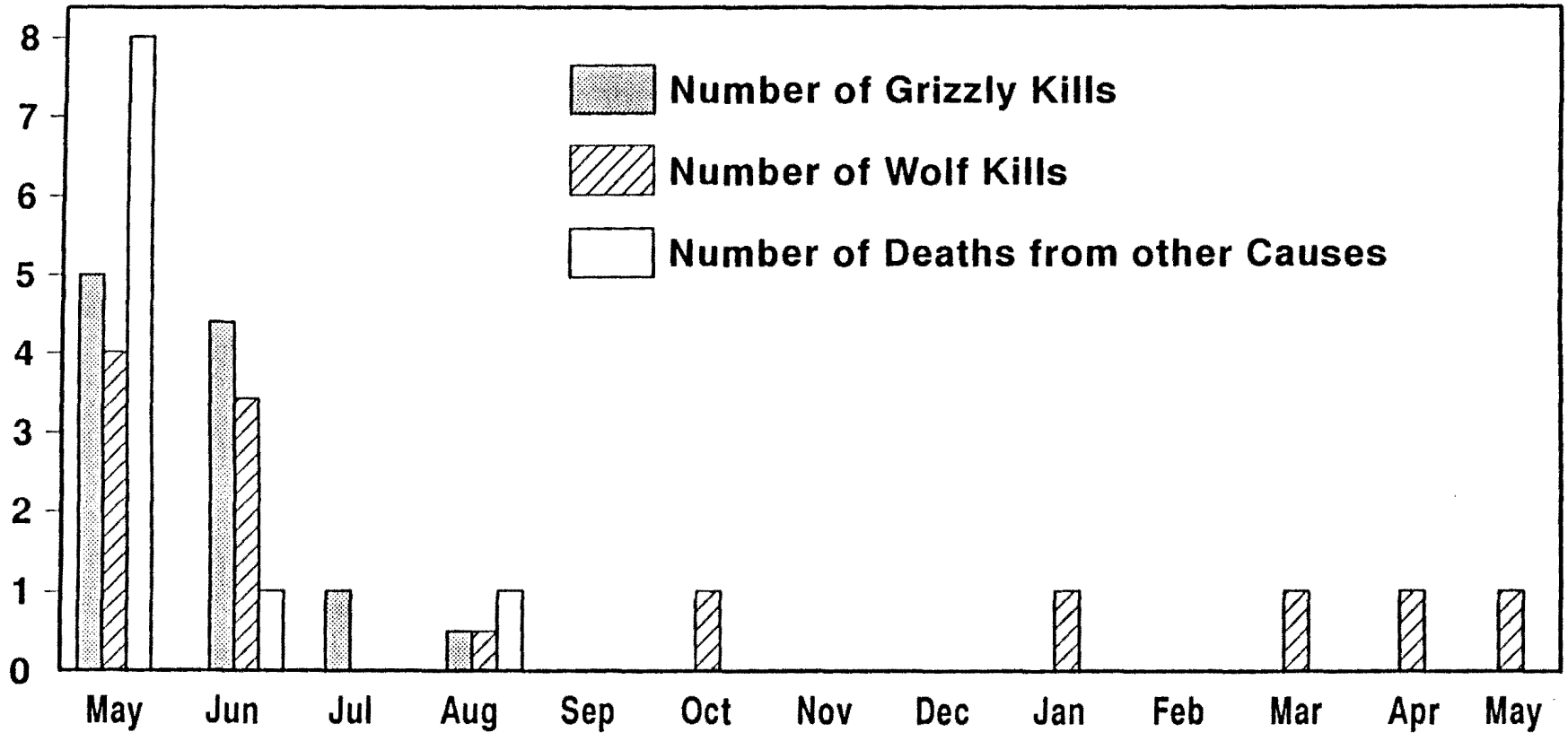

Figure 4 Chronology of wolf and grizzly bear kills and deaths from other causes among 34 caribou calves that died from May 1994 through early May 1995, Fortymile Caribou Herd, eastcentral Alaska

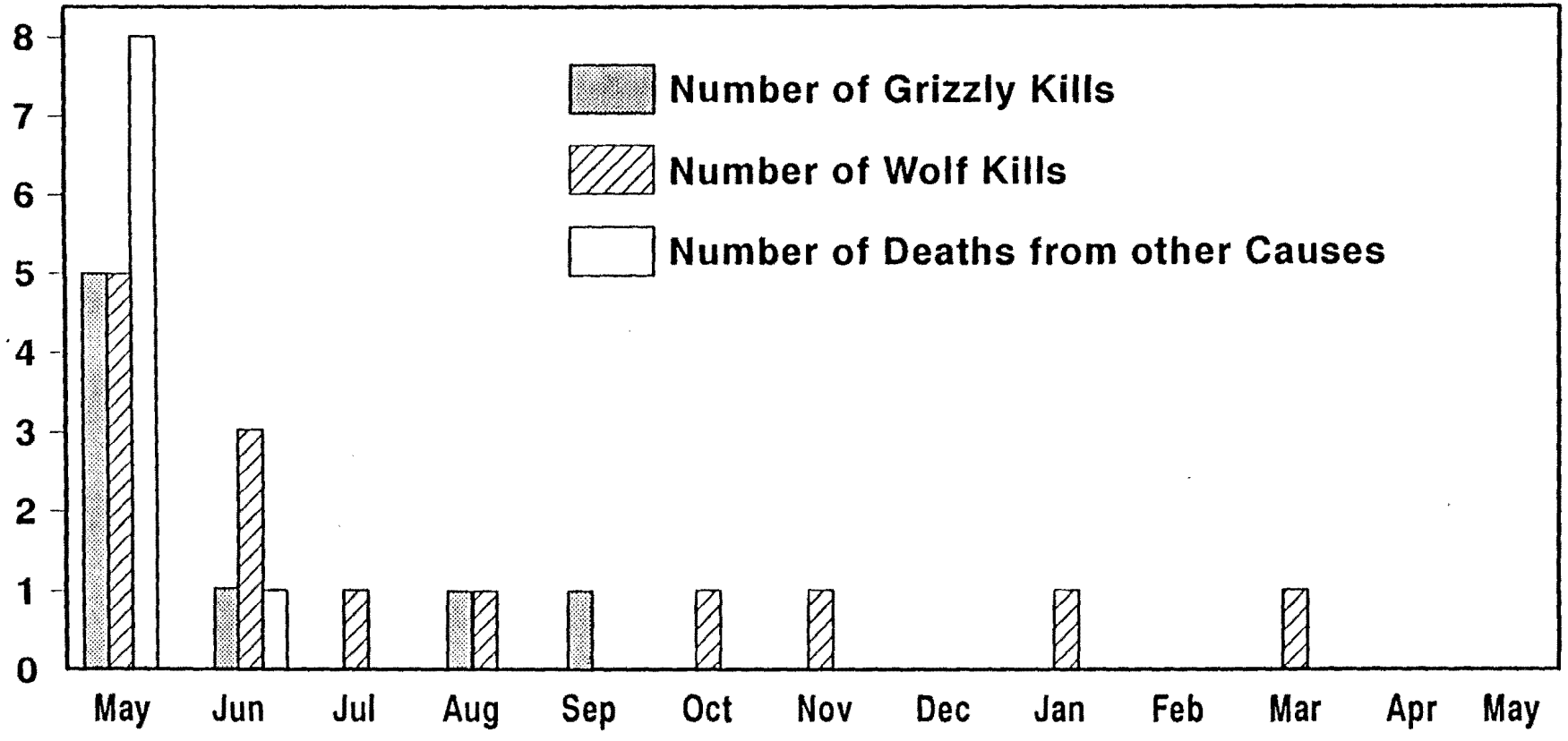

Figure 5 Chronology of wolf and grizzly bear kills and deaths from other causes among 30 caribou calves that died from May 1995 through early May 1996, Fortymile Caribou Herd, eastcentral Alaska

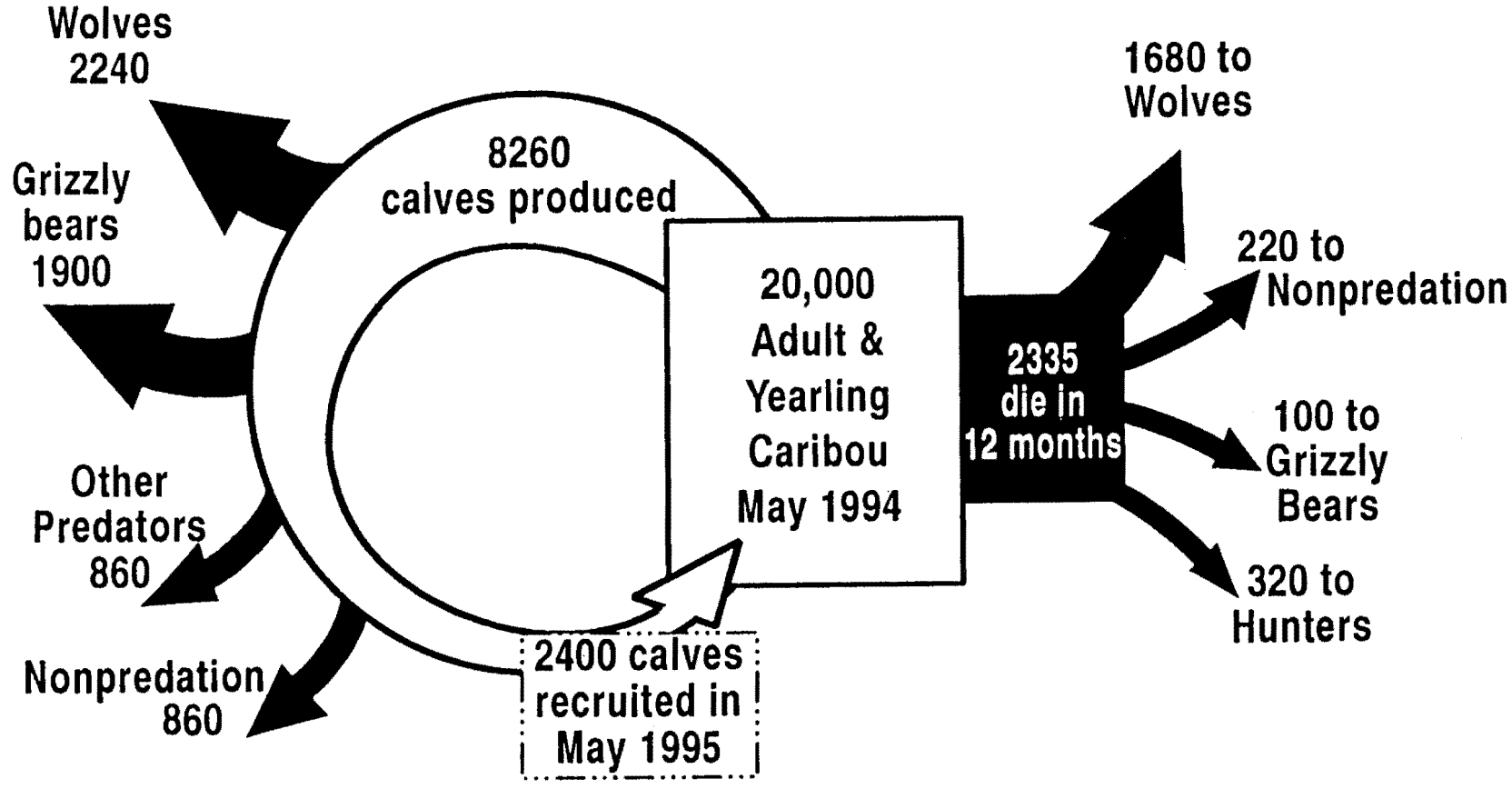

Figure 6 A conceptual model of births and deaths in the Fortymile Herd from 11 May 1994 to 10 May 1995. Black arrows point to numbers of caribou dying from specific causes during the 12-month period, as estimated from telemetry flights and follow-up investigations of causes of death. This model independently arrived at the same conclusion as recent censuses, i.e., that herd size is stable (2400 calves are recruited at the end of 12 months and 2335 adults and yearlings die during the same 12 months). Of the 8195 caribou that die in the 12-month period, wolves killed 48%, grizzly bears killed 24%, other predators killed 10%, nonpredation factors killed 13% and hunters killed 4%. This model is derived from data in Appendix B.

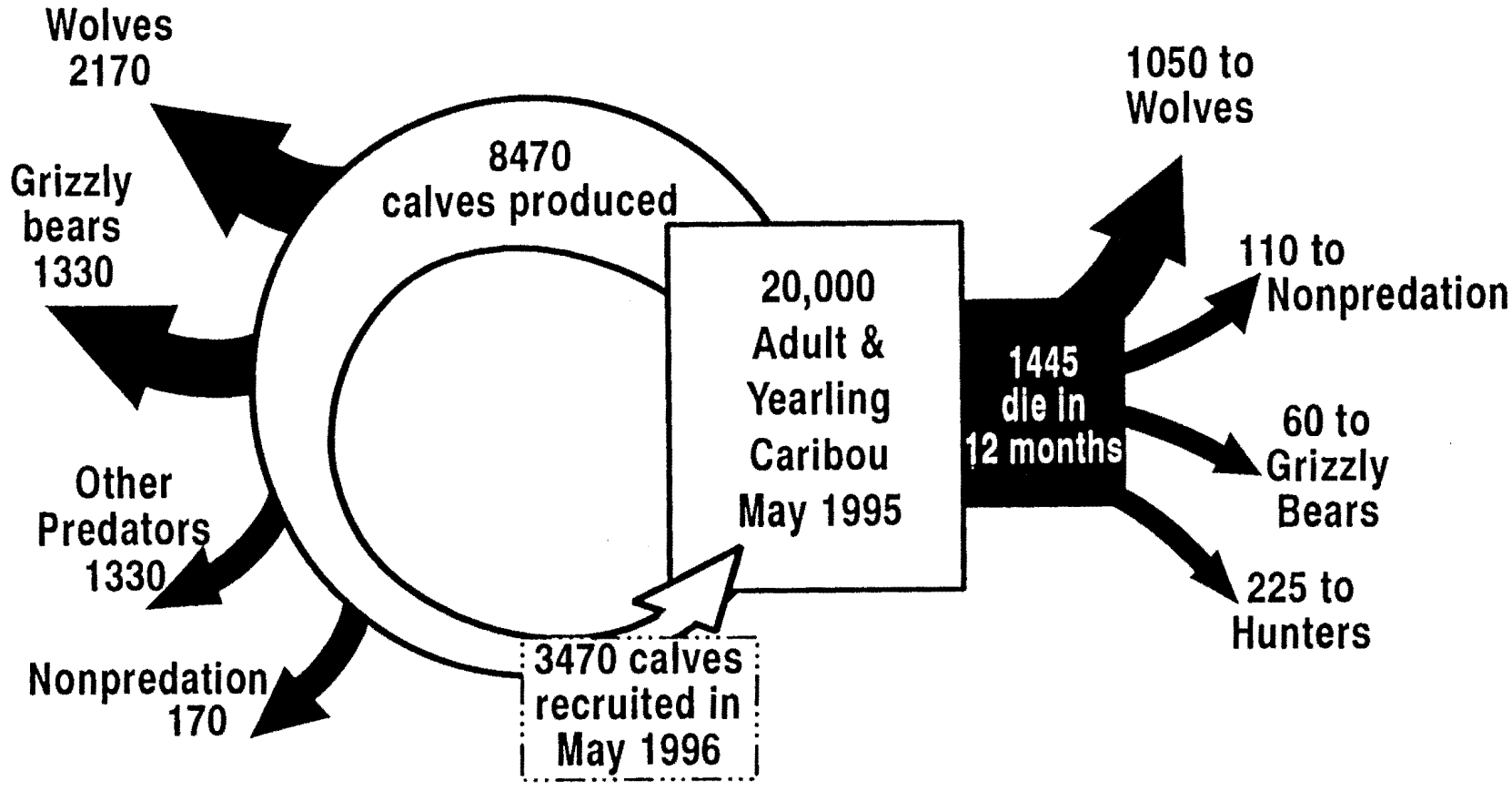

Figure 7 A conceptual model of births and deaths in the Fortymile Herd from 11 May 1995 to 10 May 1996. Black arrows point to numbers of caribou dying from specific causes during the 12-month period, as estimated from telemetry flights and follow-up investigations of causes of death. This model independently arrived at the same conclusion as recent censuses, i.e., that herd size increased slightly. Of the 6445 caribou that die in the 12-month period, wolves killed 50%, grizzly bears killed 22%, other predators killed 20%, nonpredation factors took 4% and hunters killed 3%. This model is derived from data in Appendix C.

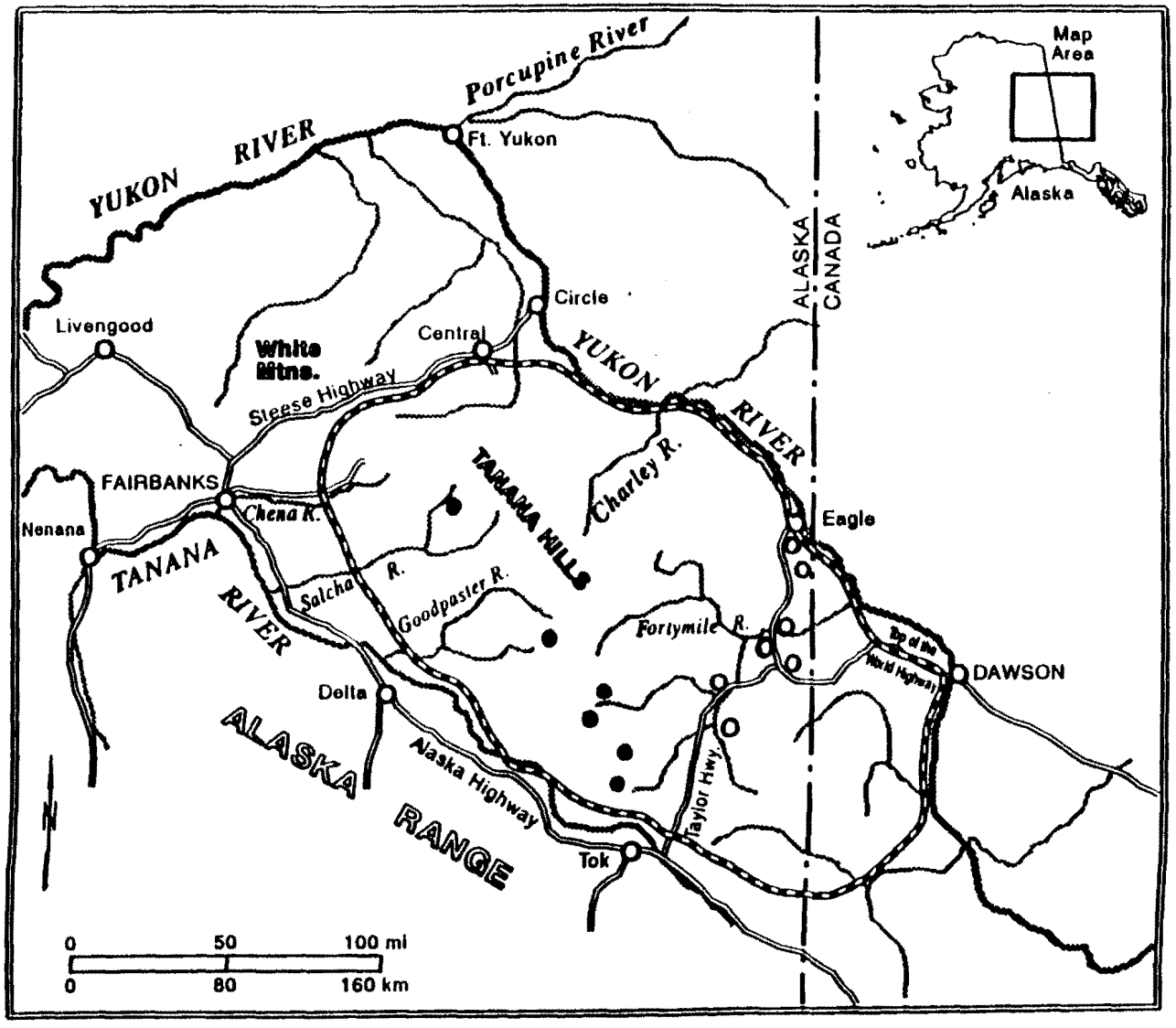

Figure 8 Locations where caribou fecal samples were collected during March and April 1992 (•) and 1993 (o)

Table 1 Estimated numbers, harvest, natural mortality, natality, and recruitment in the Fortymile Herd, 1984-1996

Year	Estimate of herd size		Estimated harvest[a] M	F	% mortality of collared caribou 4-16 months old for year ending 1 Oct (*n*)		% mortality of collared females 17-28 months old for year ending 1 Oct (*n*)		% mortality of collared females ≥ 28 months old for year ending 1 Oct (*n*)		Natality rate of collared females ≥ 36 months old (*n*)		Calves:100 females (*n*)[b] Sep to Oct	
1984	13,402	(19)[c]	430	20					10	(21)	87	(23)	--	--
1985	--	--	421	20					9	(22)	100	(19)	36	(574)
1986	15,307	(19)	360	20					17	(24)	95	(21)	28	(842)
1987	--	--	229	20					5	(19)	95	(19)	37	(1274)
1988	19,975	(39)	645	150					9	(33)	95	(20)	30	(770)
1989	--	--	400	98					19	(27)	--	--	24	(1182)
1990	22,766	(16)	321	22					40	(20)	88	(16)	29	(1002)
1991	--	--	495	10	21	(14)	--	--	17	(12)	91	(11)	16	(931)
1992	21,884	(64)	432	35	57	(14)	8	(12)	17	(35)	87	(39)	30	(1416)
1993	--	--	336	10	8	(12)	10	(10)	10	(51)	68	(47)[d]	29	(2095)
1994	22,104	(91)	315	20	17	(12)	10	(10)	11	(37)	82	(45)	27	(1710)
1995	22,558	(85)	200	25	20	(30)	10	(10)	8	(40)	85	(41)	32	(1879)
1996	23,458	(97)	--	--	18	(39)[e]	14	(7)[e]	5[e]	(42)	97	(39)	--	--

[a] Some harvest occurred during Jan, Feb, or Mar of the subsequent year, but was included in the autumn tally of the previous year.

[b] *n* = number of females ≥ 1 year old classified.

[c] Number of caribou with radiocollars during census.

[d] In 1993, 5 of 12 (42%) females 3 years old were pregnant, and 27 of 36 (75%) females ≥ 4 years old were pregnant.

[e] Data are summarized through May 1996.

Table 2 Autumn (late Sep-late Oct) weights (kg) of female calves radiocollared in the Fortymile Caribou Herd, 1990-1995

	1990	1991	1992	1993	1994	1995
	59.4	61.3	67.2	61.3	60.9	66.7
	56.7	59.0	65.3	60.3	60.7	61.3
	56.3	57.6	60.3	58.1	59.1	60.3
	55.8	57.2	60.3	58.1	58.9	60.2
	55.8	56.3	58.5	57.6	56.2	59.9
	55.4	55.4	54.4	57.6	55.9	59.0
	53.5	55.4	54.0	57.2	54.9	57.6
	52.6	54.4	52.2	57.2	54.2	57.2
	51.7	54.4	51.3	56.7	53.8	54.4
	51.7	54.4	51.3	55.8	52.8	54.0
	49.9	51.7	50.8	55.4	51.3	53.6
	49.0	48.5	50.8	54.0	49.2	52.5
	47.6	48.1	49.9	52.6	48.4	51.7
	43.1	41.3	45.4	51.7	46.0	51.0
				48.5		50.9
Mean	52.8	53.9	55.1	56.1	54.4	56.7
SD	4.32	5.12	6.28	3.32	4.60	4.6
SE	1.15	1.37	1.68	0.86	1.23	1.18

Table 3 Proportions of discerned plant fragments in 13 fecal samples collected from Fortymile caribou during March and April 1992 (n = 6) and 1993 (n = 7). Collection sites are depicted in Figure 5.

Plant genus or group	Mean % (± SD) of discerned plant fragments		
	1992	1993	Both years
Lichens	72 ± 22	81 ± 4	77 ± 15
Mosses	9 ± 8	7 ± 4	8 ± 6
Ledum	7 ± 5	5 ± 2	6 ± 4
Equisetum	7 ± 14	3 ± 2	5 ± 8
Picea	2 ± 1	2 ± 1	2 ± 1
Grass/Sedges	1 ± 1	1 ± 1	1 ± 1
Forbs	3 ± 5	0	1 ± 4
Dryas	1 ± 3	0	1 ± 2
Salix	0	1 ± 1	1 ± 2

APPENDIX A Draft Wildlife Research Study Plan, December 1996

Project No.

Study No.

Study Duration
From: July 1, 1997
To: June 30, 2002

WILDLIFE RESEARCH STUDY PLAN

Alaska Department of Fish and Game

Division of Wildlife Conservation

STUDY TITLE: Reducing Mortality on the Fortymile Caribou Herd

THE NEED:

1 Statement

This study plan provides details on how the Alaska Department of Fish and Game (ADF&G) proposes to implement management recommendations by the Fortymile Planning Team (Appendix:34). To stimulate recovery of the Fortymile Herd, the Team (Appendix:47) recommended, in part, that ADF&G study several experimental, nonlethal techniques for reducing predation on Fortymile caribou. Predation has been well documented as the major factor limiting Fortymile caribou and moose populations (Gasaway et al. 1992; Valkenburg et al. 1994; Boertje et al. 1995*a*; Boertje and Gardner, in press).

The Team's intentions are to provide conditions for the Fortymile Herd to grow at a moderate annual rate of 5% to 10% between June 1997 and June 2002 (5 years). To achieve this rate of growth, the Team proposed reducing predation, particularly predation on spring and summer calves. Table 1 summarizes the various management actions proposed in this plan and the associated time periods for implementation. The Team recommended "a methodical, step-by-step approach to ensure that biologists can learn from each step and change the methods if they do not work or if a better approach is discovered" (Appendix:41). This document provides initial ideas as to how best to implement the Fortymile management plan.

This study plan primarily addresses methods for reducing wolf predation on caribou and monitoring effects of these methods on wolves and caribou. We may also reduce grizzly predation during 1 spring and investigate the effects on bears

and caribou. Secondarily, we plan to study some broader ecosystem effects such as the impact on moose and Dall sheep, and the impact of increased large prey on scavengers, e.g., wolverines. We will also study the effects on herd composition and trend of reducing human hunting of caribou.

2 Justification for Study Plan

The Team described reasons for developing a recovery plan for the Fortymile Herd as follows (Appendix:35, 37):

- For the long-term benefit of the Fortymile ecosystem and, specifically, the biodiversity of this ecosystem;
- To help recover the Fortymile Caribou Herd to its traditional range and to benefit the people who value the herd and its ecosystem;
- To promote viewing opportunities of the Fortymile Herd during its spring and fall migrations, particularly along the Steese, Taylor, Top of the World, and Klondike highways where people once witnessed thousands of migrating caribou;
- To promote similar goals among the agencies involved in management of the Fortymile Caribou Herd;
- To resolve conflicts among interest groups;
- To encourage sound wildlife management decisions that consider diverse values.

3 Background

The Fortymile Caribou Herd has the potential to be the most economically important wildlife population in Interior Alaska and the southern Yukon. Potential for growth is indicated by Murie's (1935) estimate of 568,000 caribou during a 20-day migration across the Steese Highway in 1920, compared with an aerial photocensus of 23,458 caribou in June 1996. The Team summarized the history of the Fortymile Herd (Appendix:50), based on various citations (Murie 1935; Davis et al. 1978; Urquart and Farnell 1986; Valkenburg and Davis 1986, 1989; Valkenburg et al. 1994; Boertje et al. 1995*a*). This history helped inspire efforts to plan an active recovery of the herd. A summary of the Team's recommendations are provided in their management plan (Appendix:35, 36).

Caribou herds typically restrict range use as herd size declines. The herd has not migrated across the Steese Highway for several decades because of its reduced size. Today, the historical range of the herd is available for use by the herd. The herd's historical range encompassed 220,000 km^2 (Murie 1935) compared with about 50,000 km^2 total for all years since 1968 (Valkenburg et al. 1994, Boertje et al. 1995*a*).

Population objectives for increasing the Fortymile Caribou Herd have wide public support in Alaska and the Yukon for consumptive and nonconsumptive reasons. This public support developed because most of the herd's former range was abandoned as herd size declined and because current low numbers are, in part, a result of past errors in the predominant management beliefs.

We have learned much from management of the Fortymile Herd. Valkenburg et al. (1994) detailed a case history of the herd from 1920 to 1990. The decline in the herd from about 50,000 in 1960 to only 6500 in 1973 was partly a result of errors in the predominant management beliefs. Overharvest was allowed in the early 1970s, and, simultaneously, high numbers of wolves and unfavorable weather contributed to the herd's decline to critically low levels (Davis et al. 1978, Valkenburg and Davis 1989, Valkenburg et al. 1994). Had this overharvest been prevented, the herd would likely have declined to only 10,000-20,000 caribou during the early 1970s and may have increased to 30,000-50,000 during favorable conditions in the 1980s.

Overharvest was allowed in the early 1970s in part because of the belief that poor range condition was the major factor causing low yearling recruitment. Thus, biologists allowed high harvests and largely ignored wolf predation while awaiting a compensatory rebound in yearling recruitment from improved range. However, it was a futile vigil; calf caribou became increasingly scarce through 1973. It was mistakenly believed hunters and predators mostly killed animals that would die before successfully reproducing and wolf and grizzly bear predation were minor influences on the herd. Also, the size of the Fortymile Herd was grossly overestimated and the trend in herd size inadequately monitored (Davis et al. 1978, Valkenburg and Davis 1989).

Today harvest programs for caribou are managed much more conservatively than in the 1970s, especially during natural declines of caribou to low levels. Since 1984 radiocollaring of Fortymile caribou provided the ability to efficiently estimate herd size, recruitment, mortality, causes of mortality, and relative nutritional status (Valkenburg and Davis 1989, Valkenburg et al. 1994). Today managers know adverse weather can initiate declines in caribou herds (Valkenburg et al. 1994, Adams et al. 1995*a*, Boertje et al. 1996).

During periods of adverse weather, herd condition can decline and predation can increase (Mech et al. 1995, Boertje et al. 1996). After weather improves, prolonged declines in caribou herds can occur from continued high wolf predation because of wolves switching to caribou as primary prey and because declines in wolf numbers lag behind declines in caribou (predator lag). Examples exist where the proportion of a herd killed by wolves increased during adverse weather because caribou were more vulnerable and wolf numbers increased as caribou declined (Mech et al. 1995, Adams et al. 1995*a*, Boertje et al. 1996). Today it is a well-accepted belief that wolf and bear predation are often the major factors limiting caribou and moose at low densities (Davis et al. 1978, 1983; Gasaway et al. 1983, 1992; Boertje et al. 1987, 1988; Larsen et al. 1989; Valkenburg and Davis 1989; Adams et al. 1995*b*; Boertje et al. 1996).

Ungulate-predator relationships were first studied in a portion of the Fortymile Herd's range during the mid-1970s and 1980s (Davis et al. 1978; Boertje et al. 1987, 1988; Valkenburg and Davis 1989; Gasaway et al. 1992). These studies summarized historical and recent predator-prey relationships and documented that predation was the major factor limiting recovery of caribou and moose populations in the area.

From 1981 through 1987 management actions were implemented to reduce grizzly bear and wolf predation in a portion of the Fortymile Herd's range (Valkenburg and Davis 1989, Gasaway et al. 1992). Control of wolf numbers by department personnel was terminated before desired reductions were achieved, and grizzly bear numbers were only moderately reduced in a small portion of the range. Subsequent 7% to 10% annual increases in caribou numbers could not be definitively linked to predator control because pretreatment studies were lacking and only small reductions in predator abundance occurred in the annual range of the Fortymile Herd (Valkenburg et al. 1994).

To definitively test the effectiveness of predator control, large reductions in predation are necessary for several years (Crete and Jolicoeur 1987; Larsen and Ward 1995; Boertje et al. 1996; Farnell and Hayes, unpubl data). Large reductions in wolf numbers for several years resulted in dramatic increases in caribou numbers in central Alaska (16% per year; Gasaway et al. 1983, Boertje et al. 1996) and eastcentral Yukon (18% per year; Farnell and MacDonald 1988; Larsen and Ward 1995; Farnell and Hayes, unpubl data). In both studies, only 15% to 31% of the original precontrol wolf numbers remained by late winter during the 4 to 6 winters of effective control efforts. These are the only well-documented studies where large reductions of wolves were maintained for several winters and, subsequently, wolves were allowed to recover.

4 Proposed Management Actions/Treatments for Reducing Predation

In the following paragraphs, we describe the various management actions listed in Table 1:

- The nonlethal program recommended by the Team includes translocating (i.e., moving) wolves other than dominant pairs and controlling fertility among dominant pairs in up to 15 total packs (Fig 1) during 4 winters (1997-1998, 1998-1999, 1999-2000, and 2000-2001). It is likely we will only treat about 5 to 10 packs per winter unless winter weather conditions are unusually favorable. Fresh, unblown snow is necessary to efficiently locate uncollared wolves. A site-based approach will be taken with the highest priority going to packs that are expected to be near newborn caribou, but wolves will have to be treated in the prior winter because of logistical problems in handling wolves without fresh snow. A further complication is that calving distribution changes annually in the Fortymile Herd (Appendix:49). Also, we will treat only a portion of the packs that prey on caribou calves because at least 3 important packs live primarily in

the Yukon-Charley Rivers National Preserve (Figs 1 and 2). About 30 wolf packs feed on Fortymile caribou each year.

- Mech et al. (in press) suggested fertility control in wolves may be preferable to lethal agency control for several reasons. Ethical and political objections to lethal wolf control by government agencies are significant (Mech 1995, Boertje et al. 1995*b*, Stephenson et al. 1995). With low to moderate (< 60%) winter wolf harvest, a wolf territory is often filled in spring by a pregnant female with high spring and summer food requirements (Hayes 1995). In contrast, the absence of a litter of pups can reduce a pair's need for food by 40% to 60% during summer (Mech 1970, 1977). Also, vasectomizing males in 4 wolf packs in Minnesota and 1 in the Yukon resulted in stable or decreased pack size and retention of territories (n = 18 pack-years of data; Mech et al., in press; RD Hayes, pers commun). Reducing spring and summer wolf predation on caribou calves is a primary objective of the Fortymile Team.

- The Team recommended researching other potentially viable nonlethal techniques for reducing predation (Appendix:42,45). One such technique includes "diversionary feeding," which includes feeding wolves at dens to divert wolves from preying on newborn caribou. Wolves killed about 1300 newborn Fortymile calves each year in 1994 and 1995, and it is conceivable that several hundred calves could be saved by detaining wolves at dens. In October 1996, the Team recommended that diversionary feeding be used as an option on unsterilized wolf packs on or near the calving area. The Team approved killing up to 15 bull caribou per year to divert wolves from killing calf caribou. Preliminary data indicate feeding wolves at dens was successful in elevating caribou calf survival south of Fairbanks (P Valkenburg, ADF&G unpubl data). We will continue to monitor ADF&G results of feeding wolves at dens. Currently, we are proposing to feed wolves at up to 3 dens during May and early June 1997 to determine if feeding will detain wolves at dens.

- The Team also recommended grizzly bears be translocated from the vicinity of calving caribou during the final spring of this study (spring 2001), if grizzly bears were "strongly limiting calf recruitment" following reductions in wolf predation. We define conditions for "strongly limiting calf recruitment" in Job 4 below. The Team's plan is to provide a simultaneous treatment of both the major predators, wolves and grizzly bears, if bears simply increase their predation on calves in response to reduced predation by wolves. Continued caribou mortality studies will be instrumental in determining if bears kill more calves as wolf predation is reduced and in evaluating what other factors may take the place of wolf predation (Boertje et al. 1995*a*:Fig. 4; Boertje and Gardner, in press:Fig 7).

- Harvest quotas for caribou will be reduced from 450 bulls in 1995 to 150 bulls during 1996-2000 (Appendix:39). Biological ramifications of this action are predicted to be small, but representatives of hunting groups on the Team sanctioned reduced caribou harvest to increase the social acceptance of the plan. Social acceptance of the management plan is vital to its implementation.

- The Team stated in the plan that local trappers could assist by shifting their efforts to wolves whose territories include the summer range of the Fortymile Herd, where few wolves were being trapped. Private citizens have since formed the Caribou Calf Protection Program (see Related Projects on page 19).

For several reasons, multiple, simultaneous actions were chosen to attempt to increase Fortymile Herd size. Foremost, a consistent moderate to high annual growth rate (≥ 5% to 10%) was desired by the Team; this growth rate will be required to convince a broad scientific audience that proposed actions were indeed effective. For example, biologists have occasionally observed natural annual growth rates of 7% in the Fortymile Herd (Valkenburg et al. 1994) and the Denali Herd (Adams et al. 1995*a*), so a higher rate will be needed for several years to convince a broad scientific audience that a particular treatment was indeed effective.

Relating cause and effect is a difficult proposition in natural systems and requires gathering support for a particular hypothesis over many years and study areas. No simple procedure exists for "proving" the proposed actions will reliably and significantly increase caribou numbers.

Under favorable environmental conditions and with the proposed multiple, simultaneous treatments, the Team expects the Fortymile Herd annual growth rate could possibly exceed 10%, based on data from the 1980s and current modeling (Valkenburg et al. 1994; Boertje et al. 1995*a*; Boertje and Gardner, in press). Based on previous research and modeling (Boertje et al. 1995*a,b*), the chances of significantly increasing herd size are small if one is using single nonlethal actions to reduce predation. In the case of the Fortymile Herd, single actions are unlikely to be effective because no nonlethal treatment will occur on the central portion of the summer range, the Yukon-Charley Rivers National Preserve (Fig 1).

Given the Team's primary goal of helping to restore the herd to its former range, the Team agreed the proposed management actions should be implemented regardless of whether an increase in herd size is measured before summer 1997. Herd size was stable during 1990-1995, a period with average and below average environmental conditions. A 4% increase was measured in 1996, possibly due in part to increased wolf harvest and low snowfall (Boertje and Gardner, in press).

After the summer 2002 photocensus of the herd, results will be evaluated to determine public acceptance and the costs and effectiveness of the management actions. Early termination of the program is an option if caribou survival and numbers fail to improve by July 2000 after 3 winters of field activities (see Job 3).

STUDY OBJECTIVE

Assuming Team objectives for reducing wolf and grizzly bear predation are implemented, we will investigate effects on wolves, caribou, and grizzly bears. Secondarily, we will study the effects on moose, sheep, and wolverines. Several nonlethal, experimental actions are proposed for reducing predation.

EXPECTED RESULTS AND BENEFITS

1 We expect to make recommendations on how to reduce predation to attain specific caribou population objectives.

2 We expect to evaluate the combined effectiveness of several, simultaneous, nonlethal actions for reducing predation to increase ungulate and scavenger numbers. The Wolf Conservation Management Policy for Alaska (see 5 AAC 92.110) directs ADF&G to investigate nonlethal means of reducing predation. "Nonlethal means of reducing predation," under this proposal, include sterilizing adult wolf pairs, translocating the remaining wolves, diversionary feeding of wolves at dens, and, potentially, translocating grizzly bears.

3 We expect to initiate tests of hypotheses that will improve our understanding and management of wolf-bear-caribou-moose-human systems.

STUDY APPROACH

We will collect data on wolves, caribou, moose, sheep, wolverines, weather, and, potentially, grizzly bears to evaluate the effects of reducing predation and harvest on Fortymile caribou.

Jobs

1 Literature review. We will continue a literature review of wolf and bear translocations, canid fertility control, responses of caribou and moose to reduced predation, ecology and interactions of these predators and prey, nonlethal techniques for reducing predation, and effects of harvest on wolves, bears, and caribou.

2 Wolves. For the up to 15 packs proposed for treatment by sterilization and translocation, we will describe changes in wolf pack size and distribution before and during treatment (Fig 1). We will collect similar data from 5 to 10 adjacent pack home ranges (Fig 2). Radiotelemetry data (1992-1995) exist for 12 packs scheduled for nonlethal treatment (Fig 1) and 10 adjacent packs (Fig 2). Additional collaring of several of these packs is planned during 1996 and 1997, with radiotracking 1 to 3 times monthly and additional locations in May and June to identify the denning adults, den sites, and use of the caribou calving and summer ranges.

Wolf fertility control and translocations are scheduled for 4 consecutive winters (1997-1998, 1998-1999, 1999-2000, and 2000-2001) and will involve sterilizing adult pairs and translocating the remaining wolves. To ensure that sterilization does not interfere with gonadal cycling, males will be vasectomized using either surgical or chemical techniques (Pineda and Hepler 1981). Females will be tubally ligated if ongoing studies in the Yukon indicate this is feasible and safe. Surgical sterilization will be conducted by a qualified veterinary surgeon at a mobile field surgical station. Sterilized packs and untreated packs will be radiocollared and located concurrently 1 to 3 times monthly to describe pack size and distribution and to identify any new immigrants in sterilized packs. New immigrants will be translocated.

We will test the hypothesis that sterilized pairs and bordering unsterilized packs will maintain use of their respective territories, as previously observed in smaller study samples by Mech et al. (in press) in Minnesota and RD Hayes (pers commun) in the Yukon. Our hypothesis is that sterilization does not affect the probability of dispersal. Techniques for testing these hypotheses will follow those of Mech et al. (in press) and RD Hayes (pers commun).

Wolf translocation/moving procedures will follow those of Fritts et al. (1984) in Minnesota with the following exceptions: 1) most wolves will be moved from October through June, but no wolves < 5 months old will be moved, and 2) all wolves will be moved at least 100 miles (160 km) because of homing tendencies.

Groups of up to 5 wolves will be translocated to each of 15 remote sites throughout Alaska and the Yukon, preferably within the winter ranges of the Nelchina, Porcupine, and Western Arctic caribou herds where human use of caribou is below sustainable levels. These sites have been tentatively approved by the respective local wildlife managers, but only for a few wolves at each site. For a variety of biological and social reasons, placing a few wolves at each site was deemed preferable to moving all wolves to just 1 or 2 sites. Release sites will have prey densities ≥ prey densities in the Fortymile range.

Fritts et al. (1985) concluded that survival of translocated wolves was comparable to that of other wolves and that pup wolves remained at release sites longer and had poorly developed homing abilities compared with adults. We will test these

hypotheses using similar techniques, e.g., all wolves will be ear-tagged and 15 will be radiocollared to study homing instincts and survival rates. Our specific objective will be to determine if young, translocated wolves regularly succumb near release sites, return to or attempt to return to capture sites, or disperse widely from release sites. Wolves usually do not disperse until about 10 or 11 months of age (Ballard et al. 1987:Appendix 1). Older wolves regularly disperse, so our radiocollared sample will consist of wolves 5 to 11 months old. We will radiotrack the translocated wolves weekly during the first month and at least monthly, if possible, for the first year. Broader studies of translocated wolves will require greatly increased funding levels and satellite collars. These studies will be proposed when funding is more likely to be secured

Currently, we are proposing research on diversionary feeding of up to 3 packs in the vicinity of newborn Fortymile caribou during May and early June 1997 through 2001. Wolves are estimated to have killed 1300 newborn calves each year in 1994 and 1995, and several hundred calves could potentially be saved by diversionary feeding. We propose only an experimental feeding program at this time, which may include purchasing beaver carcasses from trappers. No feeding of wolves is proposed within the Yukon-Charley Rivers National Preserve. We will evaluate the usefulness of the feeding using techniques similar to P Valkenburg (ADF&G unpubl data.), e.g., wolves will be radiocollared and their proximity to the den will be regularly monitored. If wolves are not detained at dens by feeding, then feeding will cease. Wolf predation rates on radiocollared calves will be compared during years with and without feeding.

To evaluate the effects of increased harvest of wolves, we will estimate harvest rates of wolves in the annual range of the Fortymile Herd (about 30,000 km^2) from winter 1992-1993 through winter 2001-2002 using data on annual distribution of radiocollared caribou and extrapolations of early winter wolf densities from ≥ 16 packs in the Fortymile range. Mandatory sealing certificates for wolf hides provide reliable data on wolf harvests. Wolf densities and harvest rates have been estimated for 16 wolf packs in a 15,500-km^2 portion of the Fortymile range since 1982 (Gasaway et al. 1992:58). We expect wolf harvest rates to decline considerably during winter 1998-1999, if we initiate wolf translocations in winter 1997-1998.

3 Caribou. Techniques for estimating caribou parameters were described by Boertje et al. (1995*a*). We will continue studies of: 1) causes and rate of mortality of calf and older caribou, 2) productivity (pregnancy rates) and relative nutritional status (e.g., live calf weights in May and October) of the herd, 3) winter diet, 4) herd numbers and composition, 5) weather variables, 6) prevalence of disease, and 7) effects of harvests on herd trend and composition. Pretreatment, treatment, and posttreatment data are needed to document responses in caribou survival and productivity. Mandatory caribou harvest permits have provided reliable data on harvest since 1993. Telemetry data from ≥ 50 newborn calves and ≥ 40 caribou older than calves will be available from at least 3 pretreatment years (1994-1996) and 5 or 6 treatment years (1997-2002). The effects of treatment could last for

several years beyond 2002 if sterilized wolves continue defending their territories, so it is premature to propose posttreatment studies.

The Team requested that we state criteria for early termination of this program if the program appears ineffective. We propose 2 criteria. If the herd fails to grow 10% between June 1998 and June 2000 and wolves kill > 3500 caribou each year during 1998-1999 and 1999-2000, we will cease translocation and sterilization of wolves beginning July 2000. We estimate wolves killed 4000 Fortymile caribou (2200 caribou in the nonlethal treatment area) from 11 May 1994 through 10 May 1995. To estimate this we used proportions of radiocollared caribou killed by wolves, estimates of herd size and composition, and locations of wolf kill sites (Boertje et al. 1995a:Fig 4; Fig 3). With increased wolf harvest during winter 1995-1996, wolves were estimated to kill 3220 caribou from 11 May 1995 through 10 May 1996 (Boertje and Gardner, in press:Fig 7).

Estimates of the annual number of wolf kills is subject to high inherent variability so these estimates are inadequate as a sole criteria for terminating the program early. Growth rates are inadequate as a sole criteria for terminating the program early because caribou photocensuses occasionally strongly underestimate caribou numbers (Boertje et al. 1996). The possibility also exists for declines in wolf predation to be largely compensated for by increases in grizzly bear predation. In this case, we would treat both wolves and grizzly bears in the final year, rather than terminate the study early.

Caribou response to treatment will likely depend largely on changes in wolf and bear predation, weather, and caribou distribution and productivity. Thus, response to proposed treatment could vary considerably between years and a precise response is not predictable.

4 Grizzly Bears. If bears simply increase their predation on calves in response to reduced calf predation by wolves and little net benefit to caribou is realized, the Team desired a simultaneous treatment of both wolves and bears during the final spring of this study. Annual treatments of both predators were considered too expensive, particularly the translocation of grizzlies.

During May 1994-1996, grizzly bears killed 8% to 10% of radiocollared calves (n = 50-60) and wolves killed 8% to 11%. If grizzly bear predation on radiocollared caribou calves increases to ≥ 15% in May 1998, we will assume grizzlies are increasing kills in response to decreased wolf predation. We will then begin estimating grizzly bear density in the treatment area in 1999. Estimating bear densities requires several years of data. To estimate bear density, we hope to use hair sampling techniques under investigation by B McLellan, D Paetkau, and C Stroebeck at the University of Alberta, Edmonton or counts of bears per hour of survey (S Miller, ADF&G unpubl data). Density estimates are required before translocations occur, if we are to estimate the proportion of the bear population that will be translocated.

If grizzly bears kill ≥ 15% of radiocollared calves in May during 2 out of the 3 years 1998, 1999, and 2000, then translocation of grizzly bears (n = 30-45) is proposed for spring 2001. We will follow procedures of Miller and Ballard (1982). The Team proposed temporarily moving bears from the calving area (excluding the Yukon-Charley Rivers National Preserve) up to 150 miles (or across the Yukon River) so that bears do not return until 2 weeks after peak calving. It is the Team's objective that translocated bears return to the treatment area in mid to late June.

5 Moose. In keeping with the Team's goal of benefiting the biodiversity of the Fortymile ecosystem, we will survey moose before and after treatment to evaluate the effects of the treatment on moose. Our objective will be to document whether moose increase to above the low-density dynamic equilibrium (0.1-1.0 moose/1000 km^2) described for this wolf-bear-moose-caribou-human system (Gasaway et al. 1992). Treating the Ketchumstuk and Mosquito packs (Fig 1) will allow testing of the effects of reducing wolf predation on moose in a portion (about 2000 km^2) of the nonlethal treatment area (Fig 4). Moose in this area were surveyed in 1995 and previously (Gasaway et al. 1992). Adjacent moose survey areas not scheduled for treatment include the Charley River, surveyed in 1994, and portions of the Ladue River, scheduled for surveys in 1996 (Fig 4). Techniques will follow those of Gasaway et al. (1986:61-71) for evaluating significant differences between population estimates.

6 Dall Sheep. Using funds from annual sheep survey-inventory sources, we will survey sheep before and after treatment to document whether sheep increase after wolves are reduced in the treatment area versus adjacent untreated populations (Fig 5). Techniques will follow those of K Whitten (ADF&G unpubl data).

7 Wolverine. Using funds from annual furbearer sources, we will survey wolverines before treatment and after the Fortymile Herd increases to 50,000 caribou. Survey areas will include portions of the Fortymile and Goodpaster River drainages. Techniques will follow those of Becker (1991).

8 We will write progress reports annually, publish results, and incorporate results in future plans. Informational leaflets (e.g., *The Comeback Trail*) will be written and results will be presented at future Fortymile Team meetings and elsewhere.

Personnel

Rodney D Boertje, Wildlife Biologist III, PCN 2130; 8 months PFT in FY98-FY02
Craig L Gardner, Wildlife Biologist III, PCN 2105; 8 months PFT in FY98-FY02
Daniel V Grangaard, Wildlife Technician V, PCN 2154; 8 months PFT in FY98-FY02
Jay M Ver Hoef, Biometrician II, PCN 2206, 2 months PFT in FY98-FY02

Cooperators/Consultants

The Team requested that ADF&G solicit comments on this proposal from at least 10 qualified, appropriate scientists, unaffiliated with ADF&G. The following 10 biologists responded to our solicitations for comments.

Layne Adams, Wolf-Ungulate Biologist
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SCHEDULE

Job No.	Activity	Est. operating costs x 1000 FY98	FY99	FY00	FY01	FY02
1	Literature review	0	0	0	0	0
2	Wolves					
	Collars @ $300/collar 30 sterilized wolves 15 translocated wolves 10 nontreated wolves	9 (30 collars)	3 (10 collars)	3 (10 collars)	3 (10 collars)	3 (10 collars)
	Tranquilization @ $1200/wolf 30 sterilized wolves approx. 60 translocated wolves 10 nontreated wolves	72 (60 immobil)	48 (40 immobil)	26 (20 immobil)	26 (20 immobil)	10 (8 immobil)
	Translocation @ $300/wolf approx. 40 translocated wolves first year	12 (40 trans)	9 (30 trans)	3 (10 trans)	3 (10 trans)	0
	Sterilization @ $300/wolf 30 wolves first year	6 (20 steril)	3 (10 steril)	3 (10 steril)	3 (10 steril)	0
	Telemetry @ $1200/flight monthly flights (12) extra May and June flights (8)	24	24	24	24	24

Job No.	Activity	Est. operating costs x 1000 FY98	FY99	FY00	FY01	FY02
	Wolf surveys each winter	S&I[a]	S&I	S&I	S&I	S&I
	Telemetry of translocated wolves	6	6	6	6	
	Subtotal	129	93	65	65	37
3	Caribou					
	Collars @ $240/collar	17	17	17	17	14
	55 newborn calf collars	(70 collars)				
	15 adult collars for 5-mo-old calves					
	Deploying collars					
	neonates ($400/calf x 60)	24	24	24	24	24
	5-mo-old calves ($250/calf x 15)	4	4	4	4	4
	Telemetry @ $1000/flight	48	48	48	48	48
	daily 13 May-Jun (n = 20)					
	twice weekly in Jun (n = 8)					
	weekly in Jul, Aug, and Sep (n = 13)					
	monthly Oct-Apr (n = 7)					
	Collar retrieval for determining cause of death ($300/collar x 30)	9	9	9	9	9
	Subtotal	102	102	102	102	102
	June/July photocensus	S&I	S&I	S&I	S&I	S&I
	October surveys	S&I	S&I	S&I	S&I	S&I
4	Grizzly Bears					
	Estimate population size if grizzlies strongly limiting calf recruitment after wolf predation reduced	0.0	5.0	10.0	10.0	0
	Translocate 30-45 bears	0	0	0	73.0	0
	Subtotal	0	5.0	10.0	83.0	0
5	Moose	S&I	S&I	S&I	S&I	S&I
	Ketch-Mosquito Flats survey area					
	estimate recruitment = 2.0					
	estimate population = 6.0					
	Ladue survey area					
	Lower Charley River survey area					
6	Sheep	S&I	S&I	S&I	S&I	S&I
	Mount Harper					
	estimate recruitment = 1.0					
	estimate population size = 2.0					
	Glacier Mtn					
	Mount Sorensen					
	Charley River					
7	Wolverine	S&I	S&I	S&I	S&I	S&I
8	Write reports, draft figures, present results	9.0	9.0	9.0	9.0	9.0
	Total	240	209	186	259	148
	Total with 40.0 defrayed by use of department and personal aircraft	200	169	146	219	108
	Total without translocating grizzly bears	200	164	136	136	108

[a] S&I = survey and inventory or management funds, which are provided for in the budget regardless of implementation of this project.

RELATED PROJECTS

The Caribou Calf Protection Program (CCPP) was formed by private citizens during 1995. Beginning in winter 1995-1996, the CCPP provided trappers $400 for wolf pelts from the summer range and a portion of the winter range of the Fortymile Herd. This economic incentive approximately doubled the economic value of a wolf pelt, and resulted in a doubling of the wolf harvest rate during its first winter of implementation. This elevated wolf harvest rate (about 65% of the wolves on the herd's 1995-1996 range) and the subsequent increase of the Fortymile Herd by 900 caribou has encouraged the CCPP to continue their efforts into winter 1996-1997. The CCPP is independent of the Fortymile Team, and is not endorsed by the Team. The CCPP was the only management action implemented during winter 1995-1996 to reduce predation.

Yukon Department of Renewable Resources study of fertility control in wolves in a buffer area around a lethal wolf control area. The study is entitled "An experimental design for fertility control of wolves in the Aishihik area, southwest Yukon," and was authored by Tania Bubela in October 1995.

Superior National Forest studies in Minnesota where dominant male wolves have been vasectomized (Mech et al., in press).

Alaska Department of Fish and Game studies of diversionary feeding of wolves to increase caribou calf survival in the Delta Caribou Herd.

REPORTING SCHEDULE

Jobs 1-7: Annual reports will be in headquarters by 31 December 1998-2002.

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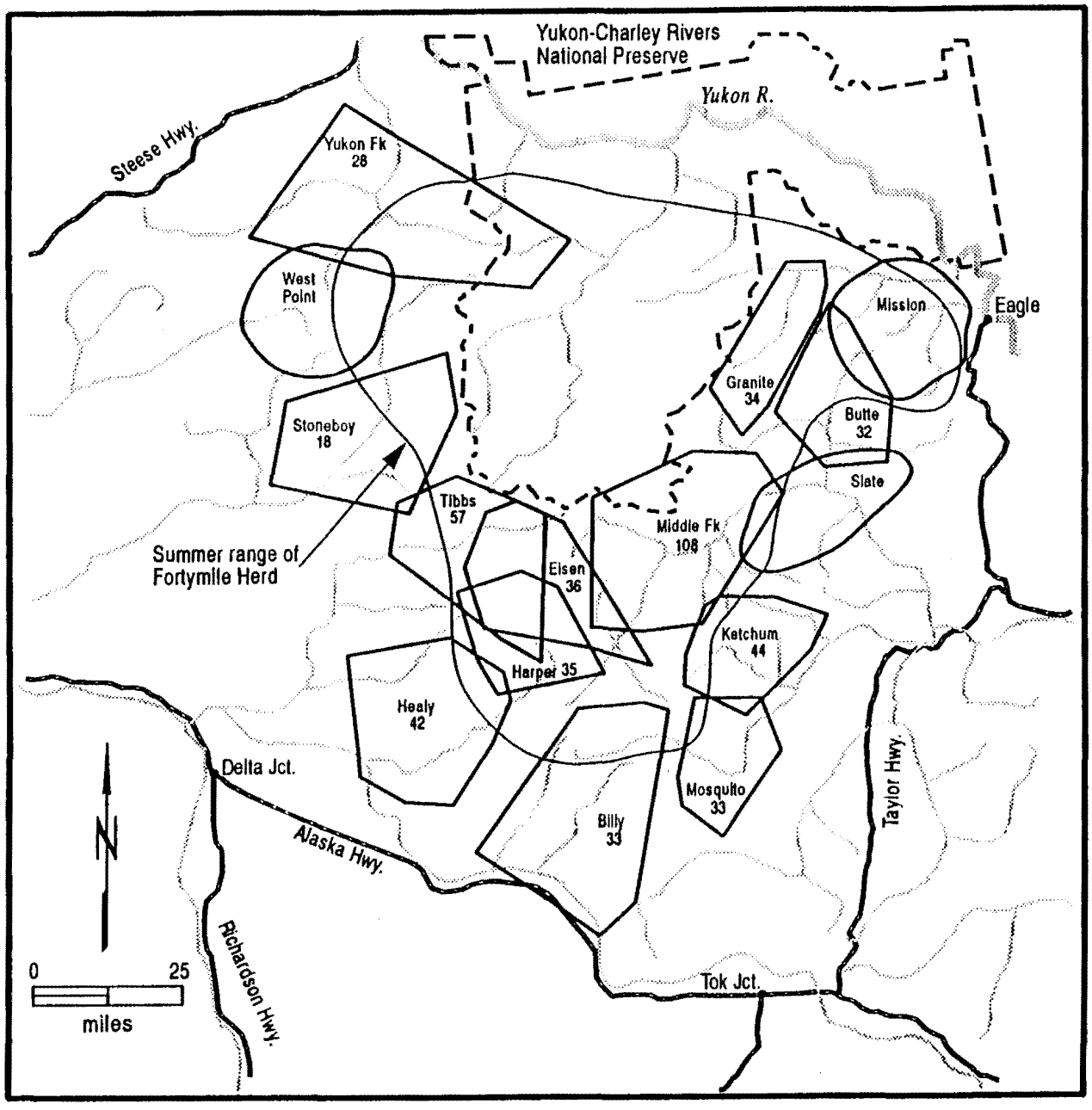

Figure 1 Approximate territories of 15 wolf packs proposed for nonlethal treatment by the Fortymile Planning Team. Territories for 12 radiocollared packs are depicted as minimum convex polygons (Mohr 1947, Peterson et al. 1984:42). Pack names are followed by the number of unique relocations of collared pack member(s) during 1992-1995.

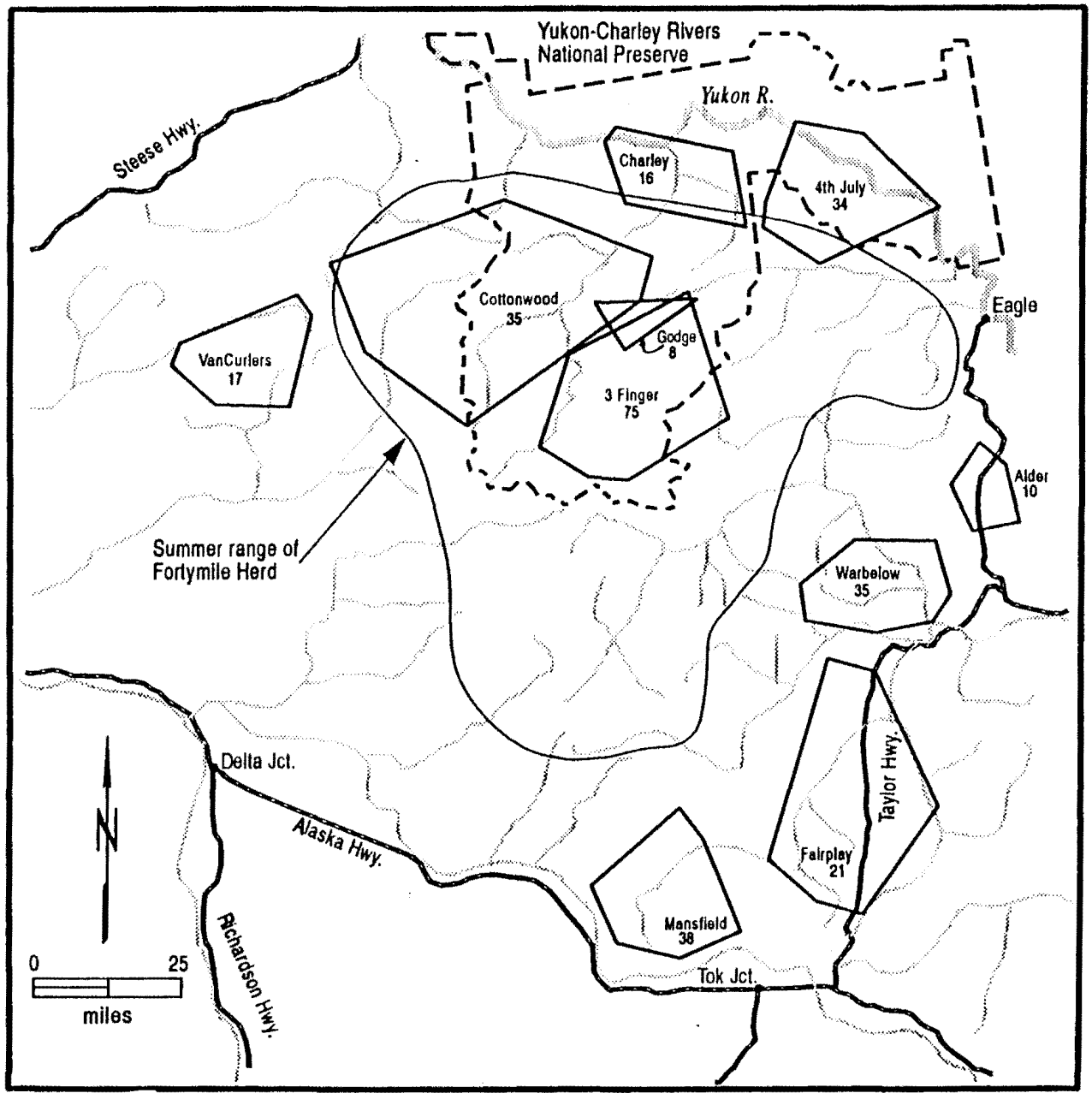

Figure 2 Approximate territories of 10 radiocollared wolf packs adjacent to the nonlethal treatment area. Territories are depicted as minimum convex polygons (Mohr 1947, Peterson et al. 1984:42). Pack names are followed by the number of relocations of collared pack members during 1992-1995.

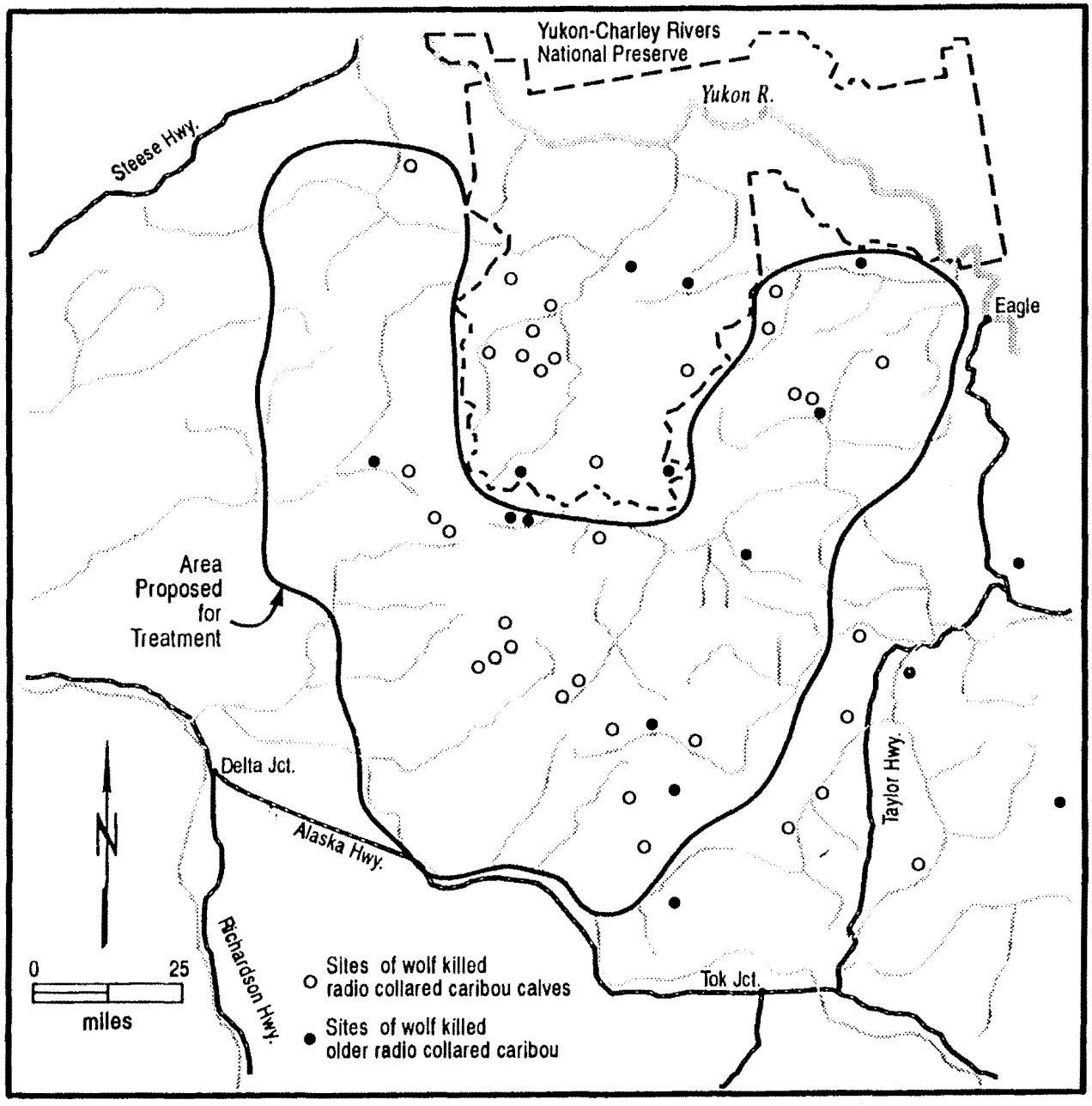

Figure 3 Distribution of wolf-killed calf (o) and older (•) caribou in and out of the proposed nonlethal treatment area, 1 October 1991-1 December 1995. These data indicate the proposed nonlethal treatment area contains about 60% of the calf kills and 50% of kills of caribou older than calves, or approximately 2200 caribou (Boertje et al. 1995*a*:Fig 4).

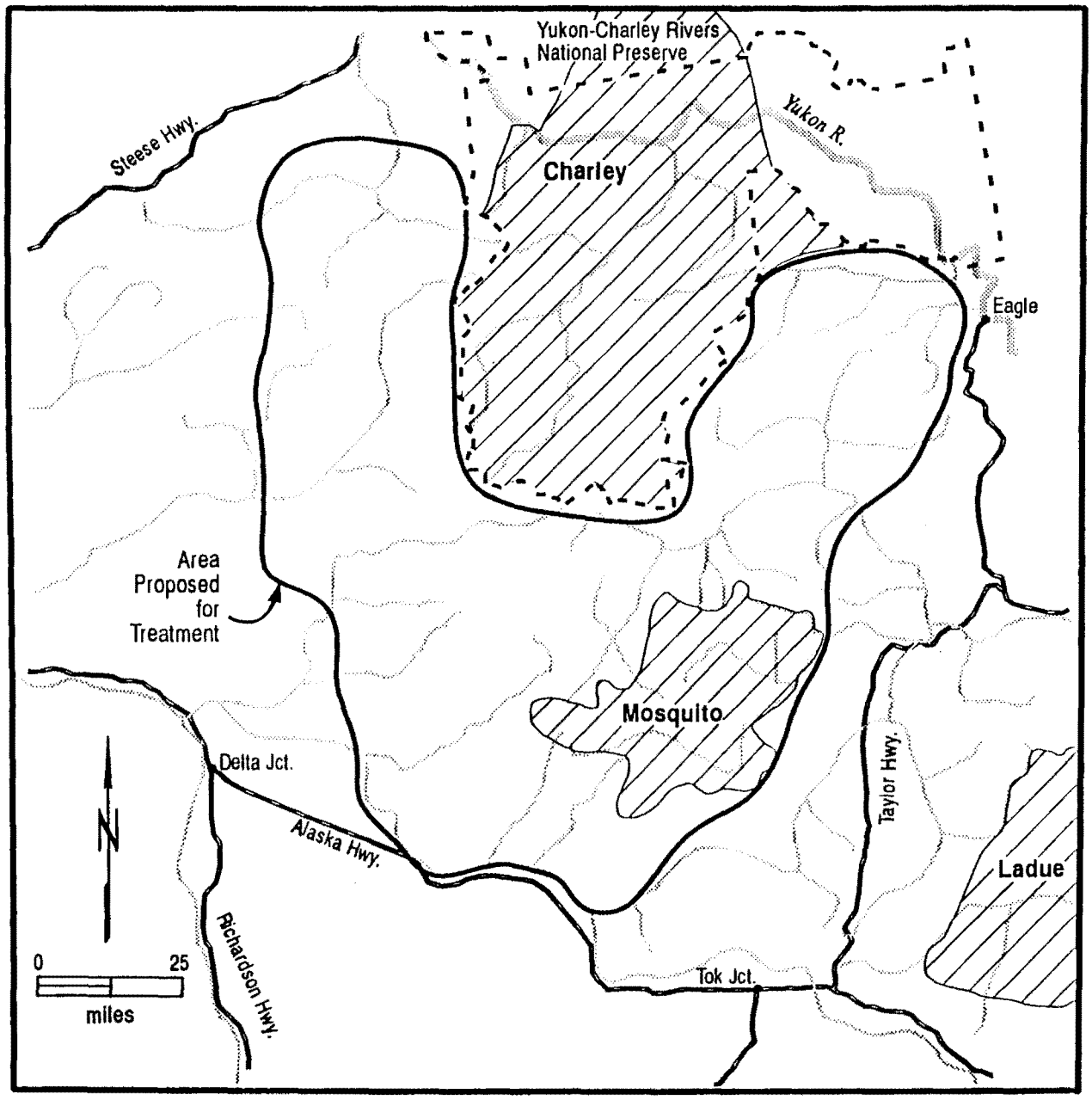

Figure 4 Moose survey areas within the proposed nonlethal treatment area (Mosquito) and outside the proposed nonlethal treatment area (Ladue and Charley) for monitoring treatment effects on moose.

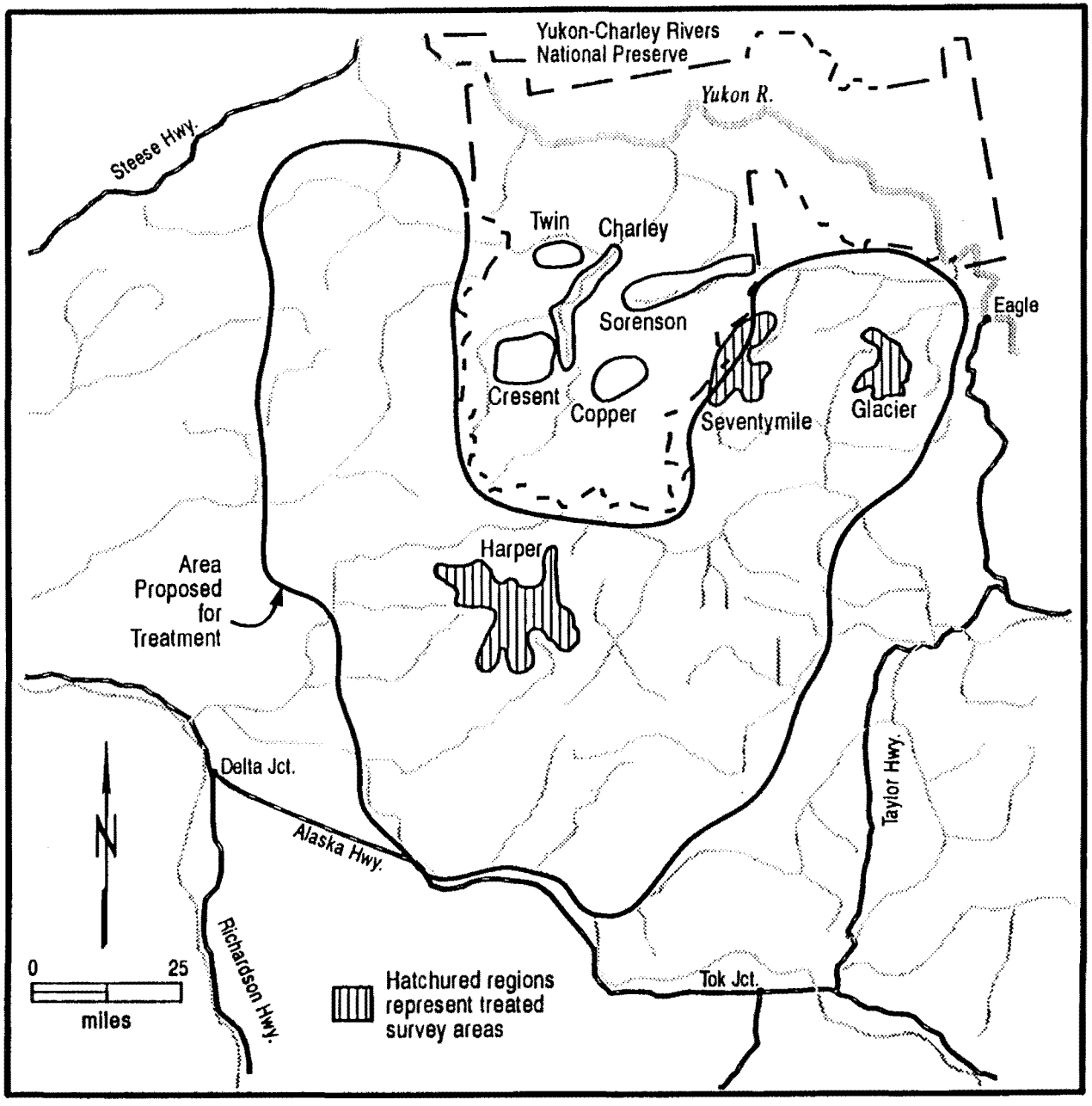

Figure 5 Sheep survey areas within the proposed nonlethal treatment area (Harper, Glacier, and Seventymile) and outside the proposed nonlethal treatment area (Cresent, Copper, Sorenson, Charley, and Twin) for monitoring treatment effects on sheep.

Table 1 Management actions proposed for the Fortymile Herd to encourage herd growth, 1995-2001

Activity and location	Plans for action and potential early termination
Wolf fertility control among 15 packs on state land (Fig 1).	• Begin during winter 1997-1998 and continue as needed through winter 2000-2001 (4 years). • Terminate fertility control in July 2000 if desired response not observed (see Job 3).
Wolf translocation of subadults and subordinate adults from up to 15 packs on state lands (Fig 1).	• Begin during winter 1997-1998 and continue as needed through winter 2000-2001 (4 years). • Terminate translocations in July 2000 if desired response not observed (see Job 3).
Diversionary feeding of wolves at dens in those 3 packs (maximum) closest to newborn caribou each year.	• Begin during May and June 1997 and continue each May and June through 2001. • If acceptable to the Board of Game, shoot up to 15 bull caribou annually to detain wolves at den sites. Wolves killed about 1300 calves in May and June 1994 and 1995.
Translocate grizzly bears from calving areas on state land in May 2001.	• Implement only if grizzly bears kill on average ≥ 15% of radiocollared calves in May of 2 of 3 years, 1998, 1999, and 2000. • Move grizzly bears up to 150 miles and onto state land with the purpose of reducing grizzly bear numbers during a period of low wolf numbers. • Team's objective is that translocated bears return to their capture sites in mid to late June when calves are large enough to escape most bear predation.
Caribou harvest reduction throughout Fortymile range.	• Quota reduced to 150 bull caribou beginning during autumn 1996 and continuing through autumn 2000 (5 years). • If wolf translocation/sterilization is not implemented in winter 1997-1998, the quota will return to 450 bulls in autumn 1998.
Monitoring of wolf harvest rates within the annual range of the Fortymile Herd.	• Comparisons will be made among winters 1992-1993 through 2001-2002 using the respective year's caribou distribution (October 1-September 30) and approximate extrapolated wolf density.

APPENDIX Fortymile Caribou Herd Management Plan. Sponsored by: US Bureau of Land Management, US Fish and Wildlife Service, US National Park Service, and Alaska Department of Fish and Game, October 1995

Table of Contents

Summary of Plan Recommendations

The idea for producing a plan to recover the Fortymile Caribou Herd originated in the Yukon, which was once a major part of the herd's range. For Yukoners, there were three primary reasons to recover the herd. First and foremost, they wanted to restore the biodiversity of this ecosystem, which once supported wildlife species in far higher numbers than it does now. Second, they wanted people to once again have an opportunity to witness the migration of thousands of caribou crossing the Taylor, Steese, and Top of the World Highways. Lastly, they wanted to restore the traditional subsistence resource of this area.

The Yukoners inspired several Alaskans to join in the effort and together they created the Fortymile Caribou Herd Planning Team—a diverse group of Alaskan and Yukon residents and representatives from state, federal, and territorial wildlife managing agencies. These agencies sponsored the effort and provided logistical support.

This team developed recommendations for recovering the Fortymile Caribou Herd and the ecosystem that depends upon it. Their recommendations are presented in this plan and summarized below.

Maintain Habitat Quality

- Maintain Fortymile caribou range quality by minimizing development of critical habitat areas and allowing a natural fire regime.
- Encourage the state, BLM, and Yukon government to designate wildlife habitat as the major use, under multiple use management, within the Fortymile caribou range.
- Work with the military to raise flight floors and reduce the number of overflights to minimize disturbance in sensitive calving and postcalving areas.

Limit the Effects of Harvest on the Fortymile Herd

- Reduce the annual Fortymile caribou harvest quota to 150 bulls during the five year plan.
- Upon completion of the plan, increase the harvest quota to at least the current level (less than 2% of the herd).

Decrease Predation on the Fortymile Herd

- Attempt to reduce predation rates on caribou calves by lowering the number of wolves and possibly grizzly bears on the calving and summer ranges using non-lethal techniques.
- Reduce wolf pack size by relocating subordinate wolves and by temporarily reducing reproduction by implementing fertility control on wolf packs whose territory includes the Fortymile herd's summer range.

- Implement monitoring methods that will ensure wolves whose range primarily includes Yukon-Charley Rivers National Preserve are protected from sterilization and relocation actions even when these packs range outside the preserve.
- Ensure that no predator management activities, excluding legal hunting and trapping, occur on NPS and BLM lands.
- Relocate grizzly bears from the Fortymile herd's calving grounds if bear predation is shown to be strongly limiting calf recruitment following two years of reduced wolf predation.

Monitor the Plan's Effectiveness

- Develop a carefully monitored research project designed by the Alaska Department of Fish and Game and world experts in the fields of ecology, wildlife veterinarian medicine, and wildlife contraception research.
- Publish results in the biannual Fortymile Caribou Comeback Trail newsletter.

Public Awareness

- Provide for increased viewing opportunities and wildlife interpretive information displays along the Taylor Highway.
- Continue to involve the public in Fortymile caribou management by arranging opportunities for individuals to participate in field activities and by soliciting comments on future management direction.
- Increase public awareness on the herd's annual population trend and range use by presenting results from the management and research studies in the Fortymile Caribou Comeback Trail newsletter.

Future Public Process

- Use a similar public planning process to resolve other statewide wildlife management issues.

For more information or additional copies of the plan, contact:

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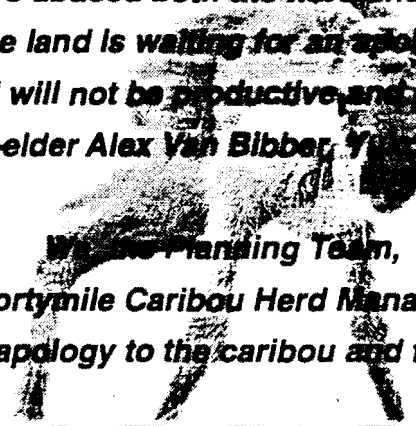
"We have abused both the herd and the land.
The land is waiting for an apology.
Until then, the herd will not be productive and give itself to people."
—elder Alex Van Bibber, Yukon—

We, the Planning Team,
offer the Fortymile Caribou Herd Management Plan
as an apology to the caribou and the land.



I. Goals and Objectives

A. Our vision for the Fortymile herd and its ecosystem.

To restore the abundance and diversity of wildlife in this ecosystem, of which the Fortymile herd is the most important indicator species.

To promote healthy wildlife populations for their intrinsic value, as well as consumptive and nonconsumptive uses.

B. Reasons for developing a Management Plan for the Fortymile herd.

1) For the long term benefit of the Fortymile ecosystem;

2) To help recover the Fortymile caribou herd to its traditional range and to benefit the people who value the herd and its ecosystem;

3) To promote viewing opportunities of the Fortymile herd during its spring and fall migrations;

4) To provide an opportunity for the caribou population to increase and expand into its historic range;

5) To promote similar goals between the agencies involved in management of the Fortymile caribou herd;

6) To resolve conflicts among interest groups;

7) To encourage sound wildlife management decisions that consider diverse values.

C. Should the herd increase?

Yes—for the reasons listed above, actions should be taken to increase the herd. Management should follow a stepwise progression of actions that is respectful of all wildlife and which increases the herd at a moderate rate (5 to 10% per year, 28,000 to 36,000 caribou).

There are two basic ways to increase the herd: 1) increase productivity and/or 2) decrease mortality. The Planning Team considered both.

II. Increase Caribou and Range Productivity

A. Are sufficient calves born each year?

Yes. Annual herd calving rates are average to high and are not limiting herd growth. Calf survival, however, is definitely a limiting factor. In 1994, about 8200 calves were born, but more than 70% of them died within a year (this and other statistics cited in the plan are discussed in a research report by Boertje, R. D. , Gardner, C., and Valkenburg, P.V. 1995. *Factors Limiting the Fortymile Caribou Herd.* Published by the Alaska Department of Fish and Game).

B. Is weather limiting population growth?

Not to our knowledge. The 1980s were favorable for herd growth and in the past 6 years, only the record early snowfall of 1992 was severe enough to result in a major decline in herd productivity.

C. Is range quality limiting herd growth? Can the range support a larger herd?

The current range is in good condition, and there are thousands of miles of traditional range which have not been used for 20 to 30 years. Research has shown that the range can support increased caribou numbers, with plentiful lichens available on the currently-used range and vast expanses of untouched former range available. Thus, protecting critical caribou range from development is of greater concern than improving range quality.

D. What can be done to maintain the productivity of the caribou range?

1. Designate wildlife habitat as a major use under multiple use management within the Fortymile caribou range. Conservation of caribou habitat should take priority over conflicting uses in areas vital to caribou.
2. We recommend a five year pause on developments that might adversely affect critical caribou habitat.
3. Work with the military to prohibit sonic booms and to raise flight floors to minimize disturbance in sensitive calving and postcalving areas.
4. Allow a natural fire regime.
5. Continue to evaluate range quality and manage accordingly. If the herd increases but does not expand its range, the team will reevaluate the plan.
6. Continue to investigate other ways to improve the range.

E. Should caribou be transplanted to this area?

Transplanting caribou was considered but not found to be a feasible way of restoring the Fortymile caribou herd throughout its historic range.

III. Decrease caribou mortality

A. Decrease Harvest

1. Is hunting pressure limiting the herd?

No. The harvest has been at low levels for several years. In 1994, for example, an estimated 8200 Fortymile caribou died, and of these, only 309 bulls were taken by hunters. Because this is less than 1.5 % of the herd and because bulls are plentiful and not as critical to the herd's growth as cows, hunting at this level is not a factor limiting the herd's growth.

2. Should the harvest be reduced? If so, why?

Yes, for three reasons:

First, although it is not a limiting factor, reducing the harvest shows respect for the declined herd and to all of the interest groups who participated in the planning process.

Second, this team believes that before any actions are taken to decrease predation, harvest should be minimized.

Third, reducing the harvest helps to isolate the effects of other management actions and is one of the few factors that can be controlled and measured.

a) **If the harvest should be reduced, what actions should be taken to do so?**

We recommend the following actions:

1) Reduce the Fortymile caribou harvest quota from 450 to 150 bulls; and
2) Encourage those who are not dependent on this herd to hunt elsewhere;
3) Change the state fall season to open after Labor Day weekend and to close the 30th of September;
4) Extend the Glacier Mountain Controlled Use Area nonmotorized restriction from the 20th to the 30th of September;
5) Close the Chicken Trail to motorized access for fall caribou hunting; and
6) Issue hunting permits only at Central, Eagle and the ADFG office in Tok;
7) Following termination of the plan, harvest quota will increase to less than or equal to 2% of the herd (which is the current level and does not limit the herd's ability to grow).

B. Decrease Predation

1. Should this plan consider ways to reduce predation? If so, why?

Yes. Research has shown that predation on calves is one of the leading factors preventing the herd from growing.

Low calf survival is the primary reason why the Fortymile caribou herd has been stable since 1989, ranging from 22,766 in 1990 to 22,558 in 1995. Out of over 8,000 calves born in 1994, an estimated 5,000 were killed by predators within a year. Born in May, two-thirds of these calves will die before September, due mostly to predation by wolves and grizzly

bears. For the herd to grow at a moderate rate, we believe predation on caribou calves must be reduced. We looked at all the options available to us and tried to find a combination that would benefit calf survival while minimizing the number of predators affected.

Some biologists believe that by reducing the effects of predation on the Fortymile herd, the herd could increase and then fluctuate naturally at a higher level. Once the herd is larger, the number of wolves will increase because of the higher prey base, but they may not have as great an impact as they now have on this herd. Therefore, further predator management is not expected.

1. Wolf Predation

a) **Should any actions be taken to reduce wolf predation? If so, why?**

Yes. Low calf survival has been the primary reason the Fortymile Caribou Herd has been stable since 1989. The majority of the calves die prior to September; ongoing research has found that wolf predation is a main cause. Far fewer calves will die in the winter. In fact, calf mortality decreases to about 12% once calves reach 5 months of age. If we want to increase calf survival, reducing summer predation is critical.

During the summer, wolves normally do not hunt as a pack but tend to hunt alone or in pairs. Individual wolves have been found to be efficient predators on caribou calves and multiple kills of calves are commonly reported. Therefore, removing individual wolves could increase calf survival.

Caribou calf survival has increased in areas where wolves were reduced but grizzly bear numbers remained the same (including the Finlayson and Delta Caribou Herds).

b) **If so, how should wolf predation be reduced?**

1) No aerial predator control and no state-sponsored trapping of wolves.

We recommend no lethal predator control for three reasons. First, lethal control clearly means that wolves would be killed and some people (although certainly not all) consider killing the animals to be less humane than using non-lethal methods. Second, more wolves would be affected under lethal control than under non-lethal. In 1992, for example, the lethal control proposal would have killed as many as 450 wolves in the Fortymile.

But if surgical sterilization (only one of the non-lethal methods to be considered here) were used, not more than 30 males and/or 15 females in the 13 packs whose territory includes the summer range would be sterilized (see maps, Appendix A). The majority of the team considered the sterilization of up to 45 wolves to be far less objectionable than lethal control and preferable to continuing the current management that has not increased calf survival. Third, we all agreed that lethal methods are also deeply divisive—they tend to make adversaries of the very people who have a common commitment to the long-term health of all wildlife populations.

c) **We recommend that wolf predation on caribou calves be temporarily reduced within the calving and summer range by reducing reproduction and by moving young adults.**

1) Temporarily reduce reproduction.

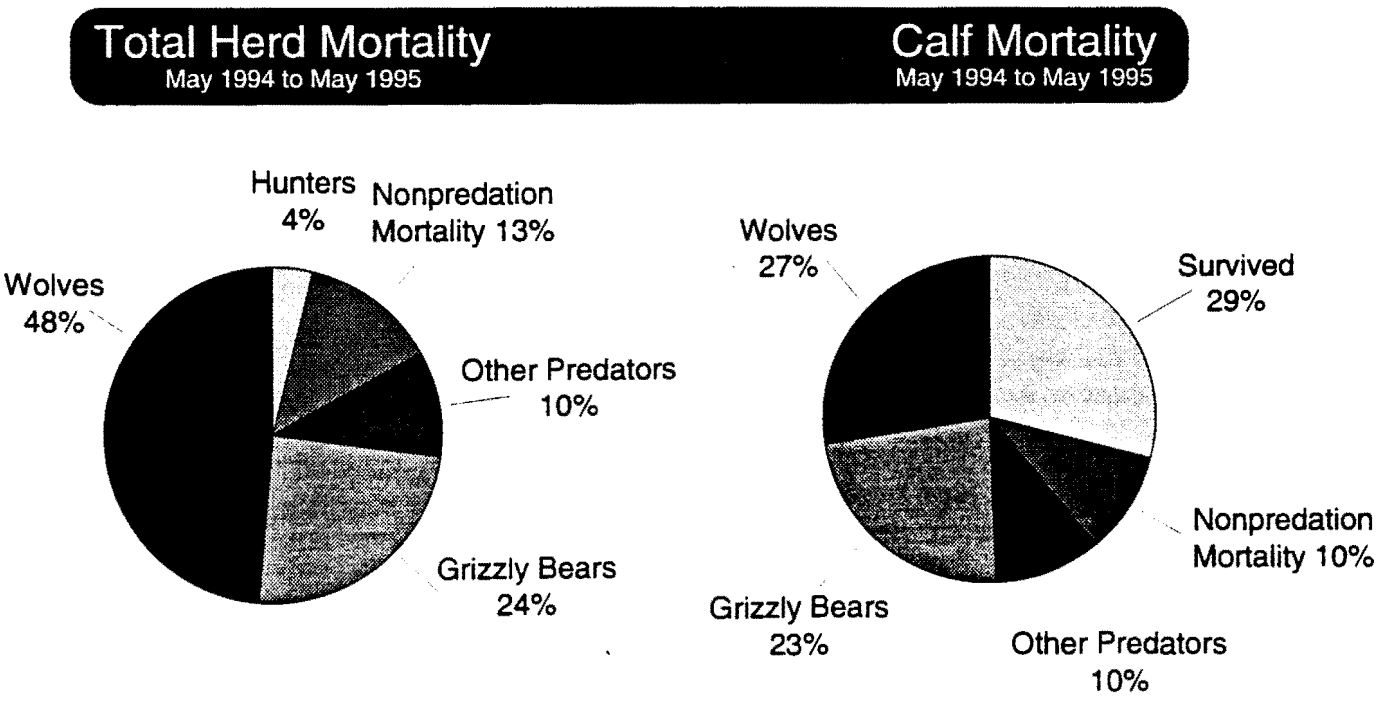
Investigate and implement a method of non-lethal fertility control of a maximum of 30 adult males and/or 15 adult females wolves whose territory includes the summer range. Worldwide, fertility control is being actively explored as a more humane approach to predator management and new research indicates that some non-lethal methods have more potential to be effective than previously thought.

Several methods of fertility control should be considered, including surgical sterilization, which are not likely to affect the sexual behavior of the animals. But before a decision is made to use surgery or any other method, additional research is needed to determine which non-lethal method involves the least human intrusion, has the least impact on the animals and the environment, and yet is still effective at decreasing calf predation. The final decision will be made by a research design team and approved by the Fortymile planning team (see Implementation section, below).

Several team members and a segment of the public were concerned that sterilization indicates disrespect for the individual wolf and takes away its wildness. The team took this concern very seriously and sought other methods, but no other method seemed to be as effective at decreasing predation on calves without also impacting many more wolves.

These methods are experimental. Therefore, we recommend a methodical, step-by-step approach to ensure that biologists can learn from each step and change the methods if they do not work or if a better approach is discovered. We recommend the Alaska Department of Fish and Game develop this as a carefully monitored research project. Because several of the methods are new, independent scientists who have experience with the techniques should review the research design.

2) Relocate young adults away from the summer range. Dispersal of young wolves is common and relocations would mimic this behavior.



By moving young adults and by reducing reproduction, the wolf population of approximately 80 to 110 wolves in the summer range is expected to be reduced by 60% during the course of this plan (outside of the Yukon-Charley Rivers National Preserve). Reduced packs have been found to maintain their territory. This is important, because it limits the number of new wolves moving into the area.

Local trappers could assist this plan by shifting their efforts to wolves whose territories encompass the calving and summer range, where little or no trapping currently occurs. This would help reduce pack size, but would not eliminate packs. The area-wide wolf harvest in the Fortymile is not expected to increase since trappers will be shifting their efforts, not increasing them.

d) **New non-lethal methods will be considered as they become available.**

e) **Where would wolf predation be decreased?**

The program would take place only within the territories of packs which impact the herd's summer range, excluding Yukon-Charley Rivers National Preserve. Current packs inhabiting the preserve (Cottonwood, Godge, and Threefinger packs) as well as any new packs will be excluded from sterilization and relocation actions even if these packs range outside the preserve. No predator management activities will occur on lands administered by the NPS and BLM.

2. Grizzly Bear Predation

a) **Should any changes be made to current bear hunting regulations?**

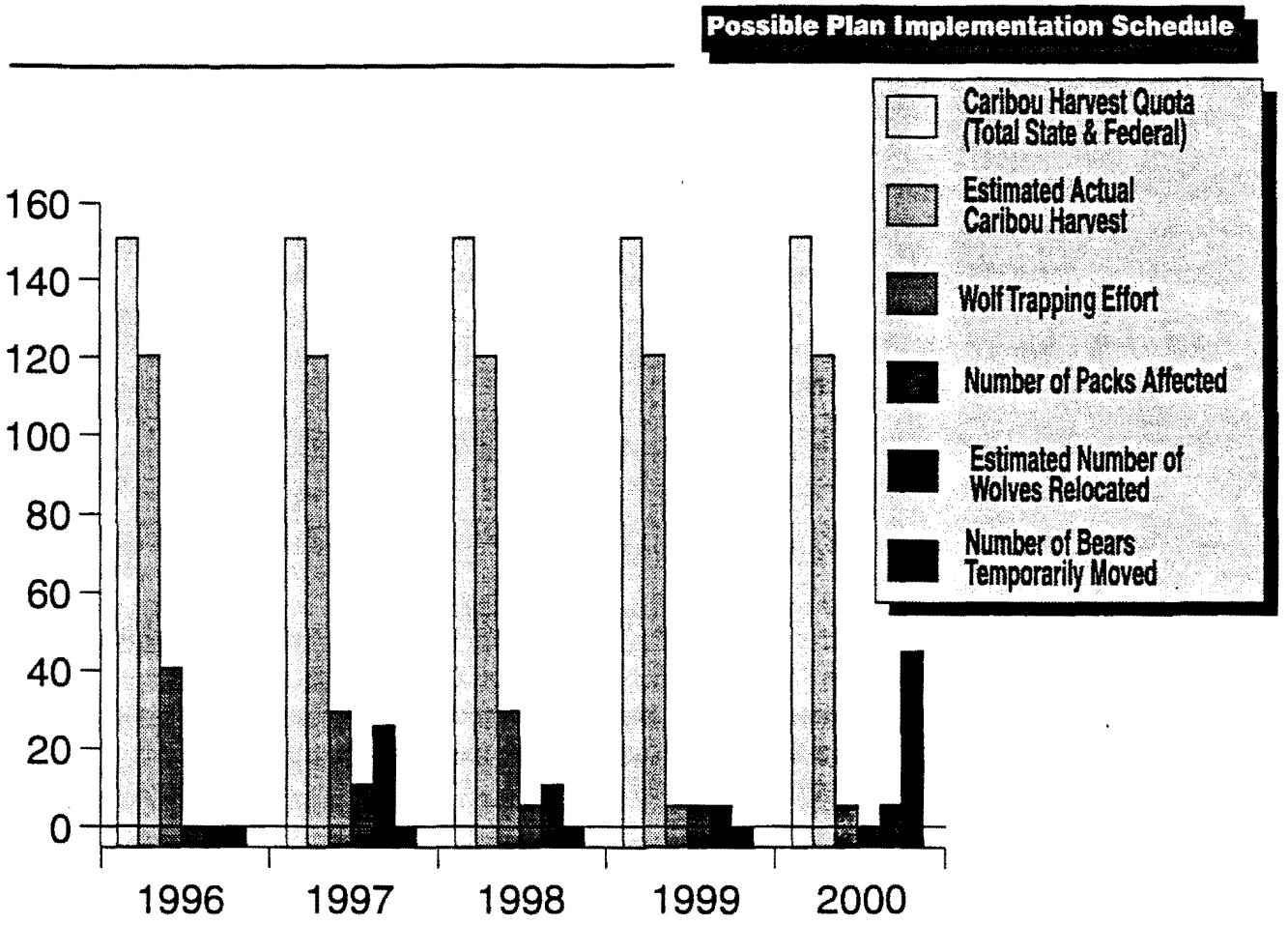
No. Maintain current bear hunting regulations.

b) **Should additional steps be taken to reduce grizzly bear predation?**

Perhaps. There are two principal reasons why we should be more cautious about reducing bear predation compared to wolf predation. First, unlike wolf predation which occurs year-round, most bear predation on caribou calves occurs in just the first 2 weeks of the calves' lives. By the end of the summer, wolves will kill more calves than bears. Secondly, unlike wolves, bears have very low reproductive rates, making them vulnerable to overharvest and much slower to recover. Thus, we should reduce bear predation only if decreasing predation by wolves does not increase calf survival.

c) **What steps do you recommend for reducing bear predation?**

If bear predation is shown to strongly limit calf recruitment after wolf predation has been reduced, we recommend that bears be temporarily moved from the calving area (excluding Yukon-Charley Rivers National Preserve) up to a maximum of 150 miles (or across the Yukon River) so that bears do not return until 2 weeks after peak calving. Bears inhabiting the preserve will not be relocated and bears will not be relocated into the preserve. This action would not occur until the final year of this plan. The objective is for all the bears that were moved to return to the area.



	Currently	Over the Planning Period				
Year	1995	1996	1997	1998	1999	2000
Total State & Federal Quota	450	150	150	150	150	150
Estimated Actual Caribou Harvest	350	100-120	100-120	100-120	100-120	100-120
Wolf Trapping Effort	30-40	30-40	30	30	0-5	0-5
Number of Packs Affected by Fertility Control	0	0	5-10	2-5	0-5	0
Estimated Number of Wolves Relocated	0	0	10-25	5-10	0-5	0-5
Number of Bears Temp. Moved	0	0	0	0	0	30-45

IV. Provide Viewing Opportunities

Notify the public when the herd is expected to cross the Taylor Highway in early October. Everyone can enjoy the spectacular fall crossing. During that time, the weather can be glorious and the tundra in full color. The caribou are robust, with full manes and shiny antlers, and people can witness bulls fighting for dominance.

V. Public Involvement and Awareness

A. What should be done to increase public awareness of Fortymile wildlife issues?

Public input is a vital part of this plan; we believe public support is essential for the plan to work. The public has been and will continue to be involved in developing this plan through this Planning Team, public meetings, written comments, the Board of Game, the Eastern Interior Subsistence Regional Advisory Council and the Federal Subsistence Board. The team should take the following steps to increase awareness of and support for this recovery effort:

a) Develop a communication and education strategy for Fortymile caribou management;

b) Identify viewing areas where people have the best chance of observing wildlife and/or hearing wolves;

c) During the planning period, increase awareness of hunting opportunities away from the Fortymile caribou herd;

d) Continue to involve the public in the direction of the program. The planning team should work with agencies to arrange opportunities for citizens to participate in field work such as habitat monitoring and caribou and wolf observations.

e) Increase awareness of the contributions hunters and trappers are making to the recovery effort. All funds for the effort are expected to come from hunting and trapping licenses and from big game tags; not from the general fund. Hunters and trappers are minimizing the caribou harvest and shifting trapping efforts to packs whose territory includes the caribou herd's summer range.

VI. Implementation

A. Future Team Responsibilities

The Fortymile Planning Team will continue to monitor implementation of the plan and to meet regularly to evaluate results and advise.

B. Research Design

A research design will be developed by ADFG in consultation with an independent team of scientists including ecologists, veterinarians and experts in fertility control. The design will be approved by the Fortymile Team. The design should focus on the most effective, timely and scientifically defensible non-lethal techniques and must include provisions to evaluate the effects on wolves and on calf survival. It must also include criteria for terminating the program if it is found to be ineffective.

C. Monitor the plan's effectiveness

1. Determine the effects of a minimal harvest on herd growth.
2. Determine effects of non-lethal fertility control of wolves on herd growth and on the area's wolf population.
3. Determine herd movement and range expansion during the life of the plan.
4. Evaluate the quality of the adjacent unoccupied range conditions.
5. Publish results in the biannual Comeback Trail newsletter.

D. Potential results

Using non-lethal fertility control as the primary action to reduce calf mortality is a new and largely untested technique and should be viewed as experimental. We do not know how well it will work. However, the team agrees we need to find alternate management methods that are more publicly acceptable that are bioligically sound.

We believe these provisions will lead to a moderate increase, about 5 to 10 % per year, in herd size. At these growth rates, we expect the herd to number between 28,000 and 36,000 by the end of the 5-year plan. We do not, however, recommend a specific herd size objective. Instead, we have attempted to specify acceptable means that will allow the herd to increase and expand its range with the fewest environmental, economic and social costs.

b) **What happens at the end of the five year planning period?**

Our intent is that at the end of five years, the actions recommended in this plan cease. At that point, the actions taken will be evaluated to determine their cost, impacts, effectiveness in reaching the plan's objectives, and public acceptance. Following the evaluation, the plan will be revised using a public process.

VII. Other Recommendations

The recommendations included in this plan have been developed specifically for recovery of the Fortymile caribou herd and may or may not be applicable to other situations.

We request that the recommendations included in the final Fortymile Caribou Herd Management Plan be taken in their entirety—they represent a package and cannot be easily separated without compromising the integrity of the agreement. If the Alaska Board of Game or the Federal Subsistence Board desires changes in the plan, the team would like an opportunity to comment.

We strongly recommend that a similar public planning process be used for resolving other wildlife management issues.

The National Park Service (NPS) believes this plan is consistent with the Department of Interior's directive for ecosystem based management. The NPS supports this plan and the process used to develop it. All State and Federal Agencies respected the different agency mandates and policies. Under this plan, no predator control or relocations will occur on the Preserve lands administered by the NPS nor will Preserve predators be sterilized or moved while outside the Preserve. It is NPS policy to advocate predator control on NPS administered lands only as a part of an endangered species management plan. Within Yukon-Charley Rivers National Preserve, the NPS will continue to protect wildlife and their habitat while allowing sport hunting, subsistence hunting, and trapping as mandated by the Alaska National Interest Lands Conservation Act.

The U.S. Fish and Wildlife Service does not have any lands under its jurisdiction within the existing Fortymile caribou range as considered in this plan. Therefore the U.S. Fish and Wildlife Service does not have a position on the predator (wolf) control issue as presented in the Fortymile caribou plan, and neither approves nor disapproves of the predator control options as presented in the plan.

Fortymile Caribou Herd Planning Team

Environmental Concerns

1. Nicole Whittington-Evans	Alaska Wilderness Recreation & Tourism Association		Supports the plan
2. Matt Singer	Alaska Wildlife Alliance		Does not support plan
3. Dave van den Burg	Northern Alaska Environmental Ctr		Supports the plan
4. Katharine Richardson	Former Taylor Hwy. resident concerned about the welfare of wolves		Does not support plan Resigned from team after the draft plan

Hunting Concerns

1. Bud Burris	Alaska Outdoor Council, Tanana Valley Sportsmen's Association		Supports the plan
2. Dean Cummings	Delta advisory committee		Does not support plan
3. Isaac Juneby	Eagle Advisory Committee		Supports the plan
4. Mike Tinker	Fairbanks Advisory Committee and Alaska Wildlife Conservation Association		Supports the plan
5. Frank Entsminger	Upper Tanana/40 mile Advisory Committee		Supports the plan

Native and Subsistence Concerns

1. Ed Kormendy	Dawson First Nation, Yukon		Supports the plan
2. Jeff Roach	Eastern Interior Subsistence Council		Supports the plan
3. George Yaska	Tanana Chiefs Conference		Supports the plan
4. Keith Jonathan	Tanana Chiefs Conference		Supports the plan
5. Kenny Thomas, Jr.	Tanacross Village Council		Supports the plan

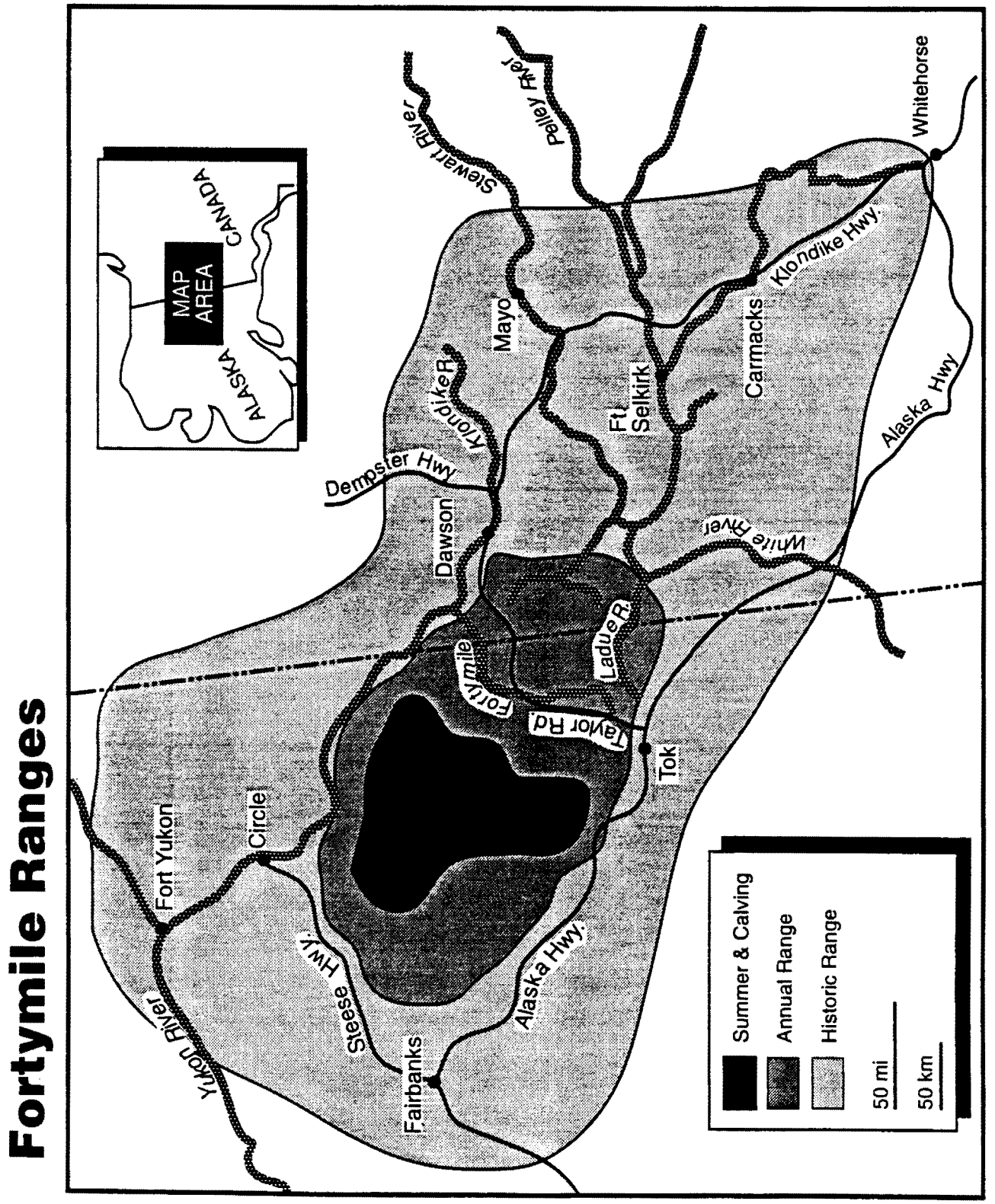
Agency Representatives

1. Ruth Gronquist	Bureau of Land Management		Supports the plan
2. Conrad Guenther	Fish & Wildlife Service		No position
3. Kevin Fox	National Park Service		Supports the plan
4. Terry Haynes	Subsistence Division Alaska Dept. of Fish and Game		Supports the plan
5. Craig Gardner	Wildlife Conservation Division Alaska Dept. of Fish & Game		Supports the plan
6. Dorothy Cooley	Yukon Renewable Resources Dept.		Supports the plan

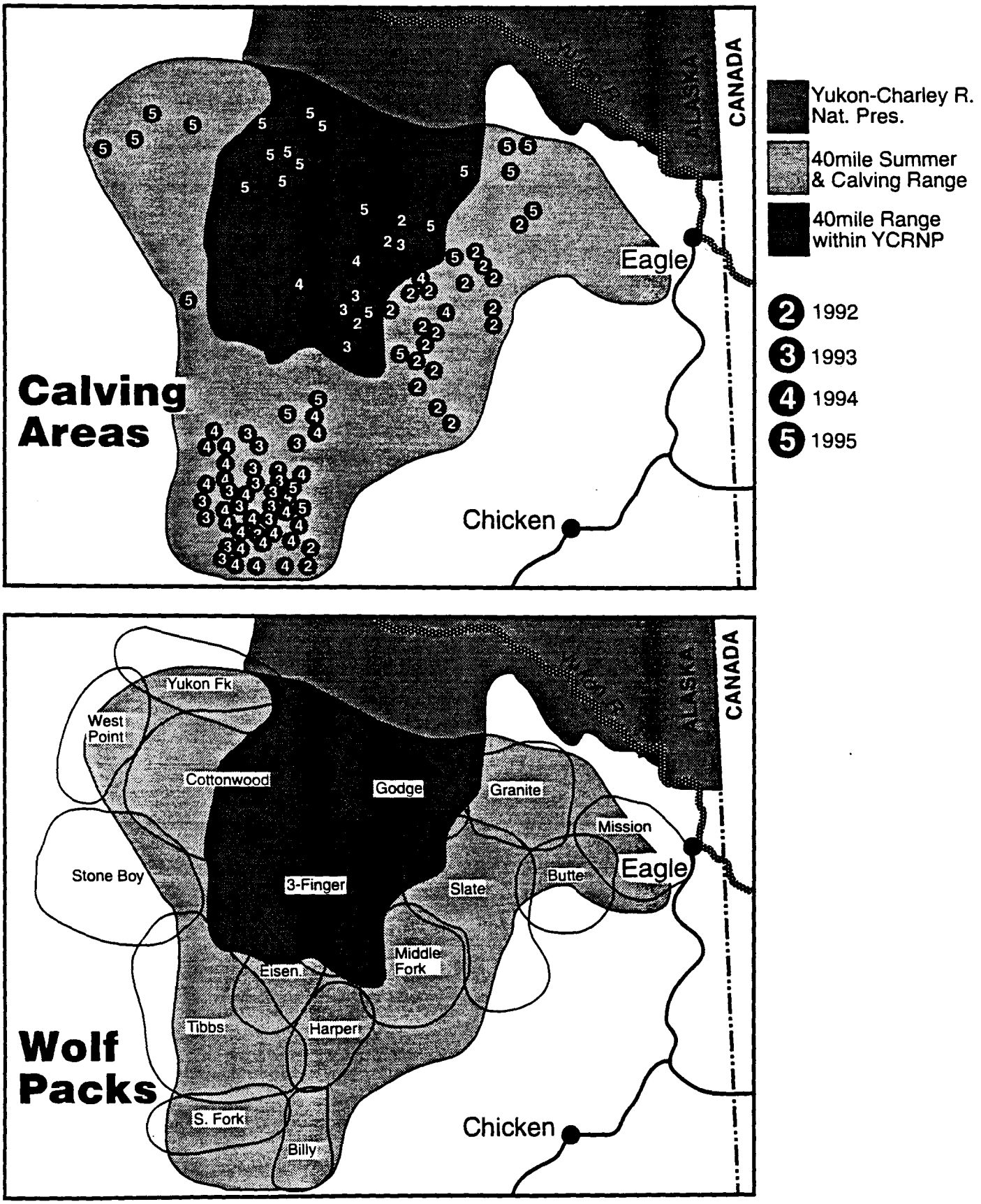
Mediator

Susan Todd	University of Alaska Fairbanks

Appendix A. Maps



40mile Calving Areas & Wolf Packs



Appendix B. History of the Fortymile Herd

During this century, the Fortymile Caribou Herd has undergone a major decline in abundance and distribution. During the early 1900s, the herd was the largest in Alaska and one of the largest in the world. In 1920, renowned biologist Olaus Murie estimated the herd to number 568,000 caribou. At that time, the herd ranged from Whitehorse, Yukon, to the White Mountains, north of Fairbanks, Alaska—some 85,000 square miles.

In the 1930s, the herd fell to an estimated 10,000 to 20,000 caribou. The cause of the decline is unknown, but possible contributing factors were loss of winter habitat due to fires, food limitation and overharvest. If Murie's population estimate was accurate, density would have been much higher than the range could have supported, making food limitation a distinct possibility. Following the decline, the herd rarely used the eastern half of its range in the Yukon.

During the 1950s, the Fortymile herd increased and may have reached 60,000 caribou by 1956. Herd size was estimated to remain between 40,000 and 60,000 until 1963.This was much lower than expected based on the high calf survival during that period and the amount of range the herd used annually. Other evidence of the herd's size at the time is biologist Ron Skoog's report that during its fall migration, this herd spanned an area 20 miles wide and 130 miles long, stretching from the Taylor Highway to the Steese Highway. The herd also used areas east of Dawson and, during some years, the entire herd wintered in the Yukon.

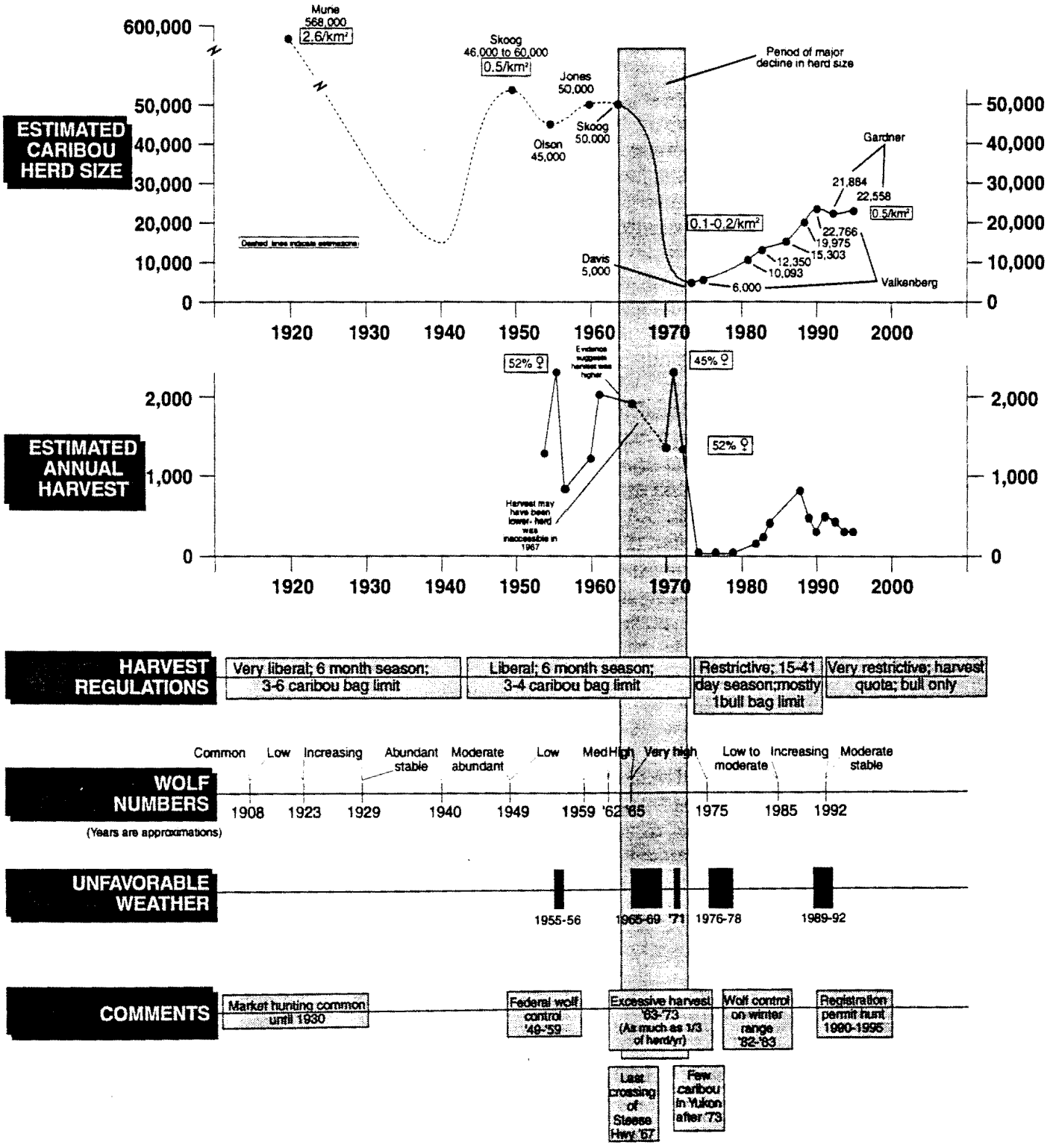
But then the population plummeted. From an estimated 50,000 animals in 1963, the herd fell to just over 6,500 in 1973. A combination of factors was to blame. Humans were definitely overharvesting the herd between 1964 and 1967 and again during 1971 and 1972. Unfavorable weather probably took a toll between 1966 and 1969 and again during 1971. In addition, high wolf numbers between 1963 and 1975 contributed to herd mortality. In 1967, the herd ceased crossing the Steese Highway and rarely crossed into the Yukon after 1973. Once called the Steese-Fortymile Caribou Herd, the herd's name has been shortened to the Fortymile Caribou Herd, since few people remember the days when the Steese Highway was closed for days during the herd's migration.

Possibly none of these factors acting alone would have led to the decline. However, poor management decisions allowed these factors to act in concert . The caribou herd was grossly overestimated during this period. The result was that high harvests were allowed. Also, the impact of wolves and bears on a declining herd was believed to be minor. If we had the census techniques we do now, these mistakes could have been prevented.

The herd began increasing again in 1976 and continued to grow until 1990. During this period, weather was generally favorable, wolf numbers were low to moderate, and harvest was relatively low. However, the herd stopped growing in 1990, coincident with unfavorable weather and increasing wolf numbers. It has since remained stable at about 22,000 caribou.

Virtually extinct in its former range in the Yukon, the vast herd that Murie watched for *20 days* as it migrated across the Steese Highway now crosses the Taylor Highway in a matter of hours.

History of the 40 Mile Herd



Appendix C. Will non-lethal management actions work?

How will the non-lethal management actions work to reduce predation on caribou calves?

- Wolf numbers will be reduced and maintained at a lower level within the Fortymile herd's calving and summer ranges.
- Wolf numbers will be reduced primarily by relocating the subordinate wolves from each pack that uses the herd's summer range but does not primarily reside within Yukon-Charley Rivers National Preserve.
- Lower wolf numbers and pack sizes will be maintained by sterilizing the alpha pair.

What needs to happen for these actions to work?

- Sterilized alpha pairs must retain their status and territories and keep new wolves from establishing territories within the herd's calving and summer ranges.
- Return rate of the relocated wolves must be low. If these wolves returned, pack size and pup production might not be adequately reduced.
- Compensatory predation by single wolves not associated with packs or by the alpha pair must not become excessive.
- The kill rate by grizzly bears must remain comparable to current levels.
- Mortality rates of relocated wolves must be comparable or lower than mortality rates for naturally dispersing wolves.

What evidence indicates the management actions might work?

- Individual wolves kill many calves. It has been documented that during 1994 an 1995 individual wolves killed between 25 and 40 Fortymile calves during the first 15 days of calving. By reducing the number of wolves, the actual number of calves killed by wolves may decline.
- Wolf pups increase the pack's food requirements. Pack nutritional requirements increase up to 60-70% during pup rearing.
- Limited evidence collected in the Yukon (1 pack) and in Minnesota (6 packs) indicates that sterilized alpha wolves will maintain their status in the pack and the reduced packs will maintain their territories.

- Subordinate wolves commonly disperse. Most wolves disperse as yearlings or 2-year-olds but some disperse as pups or even when they are 3 years and older. Average distances moved by dispersing wolves in Alaska are 50-70 miles.

  Wolves relocated greater than 40 miles away from their home territories in Minnesota did not return. The survival rate for the relocated wolves, including pups, was comparable to resident wolves. There are areas of state land in Alaska that support few people, few wolves and high ungulate populations that could be used as relocation sites.

- By relocating subordinate wolves and restricting reproduction by the alpha wolves, the wolf population with the herd's calving and summer range will be reduced by about 60%. The population may be reduced further if additional wolves are removed by subsistence trappers.

- The benefits of the program will continue as long as the alpha pair retains its territory.

- Studies in Denali National Park found the large majority of the alpha male and female wolves were not genetically related. These data indicate that even in areas without hunting and trapping, unrelated wolves are accepted into existing packs or form new packs and the family pack structure is continually changing. Therefore, dispersal plays a large part in wolf ecology in Alaska.

- Grizzly bear predation rates on caribou calves decline substantially once the calves are two weeks old.

- Grizzly bears are not species-specific predators and select other food sources, especially once the plant growing season begins.

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Consultants:

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Rick Farnell, Yukon Department of Renewable Resources, Whitehorse, Yukon.

Robert Hayes, Yukon Department of Renewable Resources, Haines Junction, Yukon.

Dr. Terry Boyer, University of Alaska Fairbanks, Fairbanks, Alaska.

Dr. Tanya Bubela, University of Sydney, Sydney, Australia

Rodney Boertje, Alaska Department of Fish and Game, Fairbanks, Alaska.

Bruce Dale, Alaska Department of Fish and Game, Fairbanks, Alaska.

Appendix D. Comparison of Operating Costs

Estimated Operating Costs by Year and Activity

(Dollars x 1000)

ACTIVITY	Alternative 1 (No Change) 1996	1997	1998	1999	2000	Alternative 2 (Team Proposal) 1996	1997	1998	1999	2000	Alternative 3 (Aggressive Action) 1996	1997	1998	1999	2000
Monitor Caribou Harvest	6.5	6.6	6.7	6.8	6.9	5.6	5.7	5.8	5.9	6.0	5.6	5.7	5.8	5.9	6.0
Wolf Population Estimate	3	3.1	3.2	3.3	3.4	5.0	5.1	3.2	3.3	3.4	5.0	3.1	3.2	3.3	3.4
Wolf Sterilization	0	0	0	0	0	0	0	26.5	3.5	3.5	0	0	0	0	0
Wolf Reloction	0	0	0	0	0	0	0	70.0	12.0	11.1	0	0	0	0	0
Wolf Radio Surveys	0	0	0	0	0	0	0	2.5	2.6	2.7	0	0	0	0	0
Caribou Surveys	8.5	8.5	8.6	8.7	8.8	8.5	8.5	8.6	8.7	8.8	8.5	8.5	8.6	8.7	8.8
Caribou Research	63.0	37.0	37.0	37.0	37.0	63.0	37.0	63.0	63.0	63.0	63.0	37.0	63.0	63.0	63.0
Informational Newsletters	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Team Meetings	0	0	0	0	0	5.0	5.0	5.0	5.0	5.0	0	0	0	0	0
Lethal Wolf Removal	0	0	0	0	0	0	0	0	0	0	98.0	38.5	38.5	38.5	38.5
Grizzly Bear Relocation	0	0	0	0	0	0	0	0	0	73*	0	0	0	0	0
										* If required					
TOTAL ANNUAL COST	84.0	58.2	58.5	58.8	59.1	90.1	64.3	187.6	107.0	179.5	183.1	95.8	122.1	122.4	122.7
Additional Cost over 5 years, Compared to the No Change Alternative	318.6					309.9					327.5				
Estimated Number of Caribou in 5 years	22,000 to 28,000					28,000 to 36,000					35,000 to 45,000				

APPENDIX B Values and calculations used to model caribou population dynamics, Fortymile Caribou Herd, May 1994-May 1995

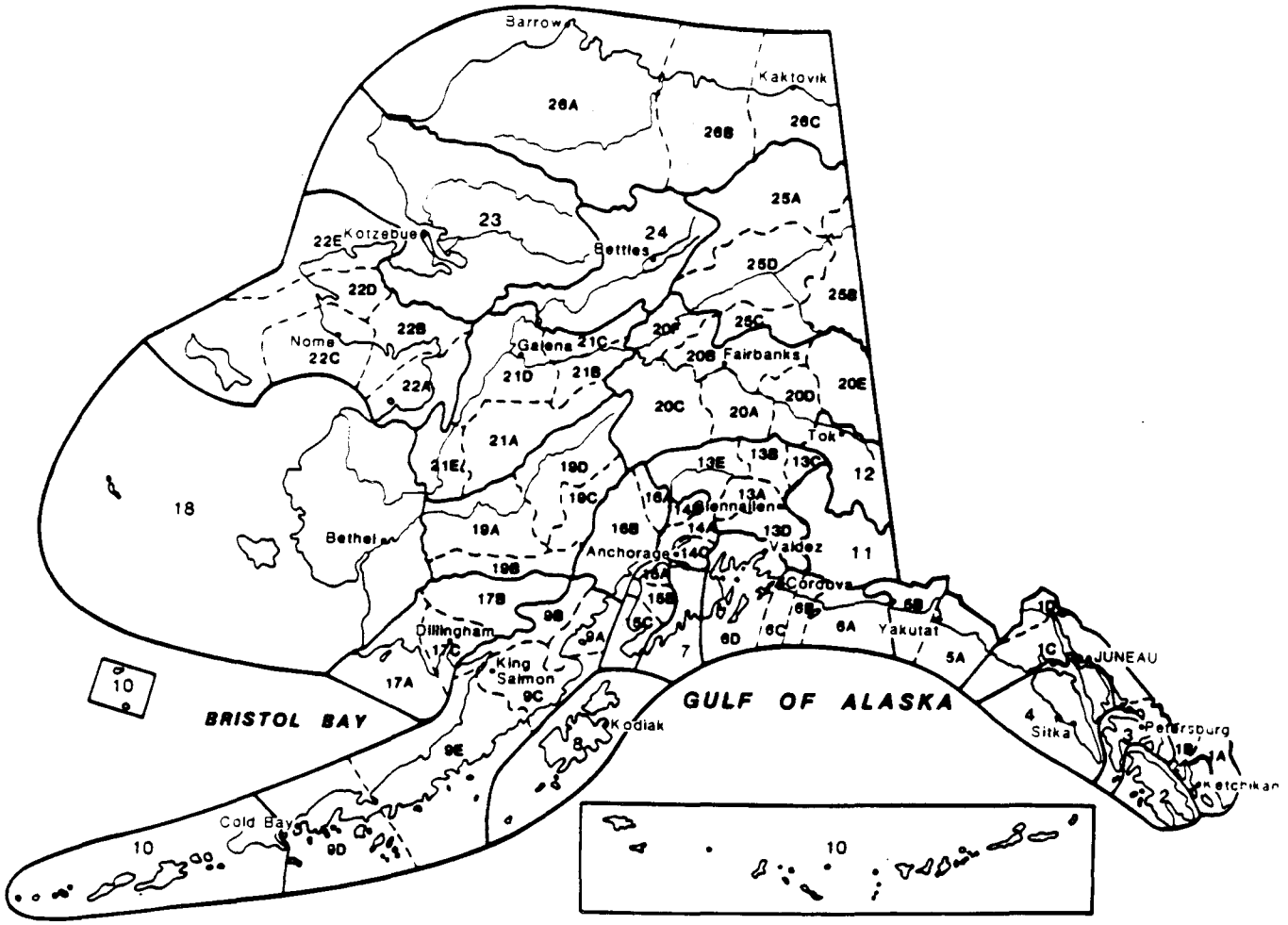
Estimated parameters and calculations	Observed or calculated values
Number of cows ≥ 24 months old in early May 1994; percent cows in herd in October 1993 when randomly mixed (0.58) x estimated herd size in early May 1994 (20,000).	11,600
Number of 24-month-old cows in early May 1994; percent calves in herd in October 1992 (0.17) x estimated herd size in early May 1993 (20,000) x survival rate from 12 to 24 months old (0.90) x proportion of females (0.5).	1530
Number of cows ≥ 36 months old in May 1994 (11,600-1530).	10,070
Number of calves produced in May 1994 (10,070 x 0.82).	8260
Number of calves dying by 10 May 1995 (8260 x 0.71).	5860
Number and cause of calf deaths, 11 May 1994-10 May 1995.	
Wolf (0.382 x 5860)	2240
Grizzly bears (0.324 x 5860)	1900
Other predators (0.147 x 5860)	860
Nonpredation (0.147 x 5860)	860
Number of caribou ≥ 12 months old in early May 1994.	20,000
Number of nonhunting deaths among caribou ≥ 12 months old from May 1994-May 1995 (20,000) (5 ÷ 50).	2000
Number and cause of nonhunting deaths among these 2000 caribou.	
Wolf (0.84 x 2000)	1680
Nonpredation (0.11 x 2000)	220
Grizzly bear (0.05 x 2000)	100
Annual harvest of adults and yearlings May 1994-May 1995.	335
Herd size 11 May 1994.	20,000
Herd size 10 May 1995 (20,000 + 8260 - 5860 - 2000 - 335).	20,065
Herd trend approximately stable.	

APPENDIX C Values and calculations used to model caribou population dynamics, Fortymile Caribou Herd, May 1995-May 1996

Estimated parameters and calculations	Observed or calculated values
Number of cows ≥ 24 months old in early May 1995; percent cows in herd in October 1994 when randomly mixed (0.57) x estimated herd size in early May 1995 (20,000).	11,400
Number of 24-month-old cows in early May 1995; percent calves in herd in October 1993 (0.16) x estimated herd size in early May 1994 (20,000) x survival rate from 12 to 24 months old (0.90) x proportion of females (0.5).	1440
Number of cows ≥ 36 months old in May 1995 (11,400-1440).	9960
Number of calves produced in May 1995 (9960 x 0.85).	8470
Number of calves dying by 10 May 1996 (8470 x 0.59).	5000
Number and cause of calf deaths, 11 May 1995-10 May 1996.	
Wolf (0.433 x 5000)	2170
Grizzly bears (0.267 x 5000)	1330
Other predators (0.267 x 5000)	1330
Nonpredation (0.033 x 5000)	170
Number of caribou ≥ 12 months old in early May 1995.	20,000
Number of nonhunting deaths among caribou ≥ 12 months old from May 1995-May 1996 (20,000) (3 ÷ 49).	1220
Number and cause of nonhunting deaths among these 1220 caribou.	
Wolf (0.86 x 1220)	1050
Nonpredation (0.09 x 1220)	110
Grizzly bear (0.05 x 1220)	60
Annual harvest of adults and yearlings May 1995-May 1996.	225
Herd size 11 May 1995.	20,000
Herd size 10 May 1996 (20,000 + 8470 - 5000 - 1220 - 225).	22,025
Herd trend increasing.	

NOTES

Alaska's Game Management Units



The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program allots funds back to states through a formula based on each state's geographic area and number of paid hunting license holders. Alaska receives a maximum 5% of revenues collected each year. The Alaska Department of Fish and Game uses federal aid funds to help restore, conserve, and manage wild birds and mammals to benefit the public. These funds are also used to educate hunters to develop the skills, knowledge, and attitudes for responsible hunting. Seventy-five percent of the funds for this report are from Federal Aid.

KEN WHITTEN